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A GUIDE
TO
PHOTOGRAPHY;

CONTAINING

SIMPLE AND PRACTICAL DETAILS OF THE LATEST AND MOST IMPROVED PROCESSES FOR THE PRODUCTION OF PICTURES BY THE CHEMICAL ACTION OF LIGHT;

INCLUDING

PHOTOGENIC DRAWING,

CALOTYPE, DAGUERREOTYPE,

CRYSOTYPE,	CYANOTYPE,
ANTHOTYPE,	FERROTYPE,
ENERGEATYPE,	TITHONOTYPE,

AND

THERMOGRAPHY.

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ILLUSTRATED WITH WOOD CUTS.

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PREFACE.

The following pages, containing many extracts from the most recent works of Lerebours, Chevalier, Fizeau, and others, are offered to the public, in the hope that they will prove a useful and correct guide to many who may wish to practise the interesting and beautiful art of Photography.

123, Newgate Street,

April, 1847.

PHOTOGRAPHY.

CHAPTER I.

INTRODUCTION AND HISTORY.

THE observation of the nature and properties of Light, and the peculiar changes which it undergoes in its qualities or direction, when passing through bodies of different forms—when reflected from their surfaces—or when moving past them at small distances, constitutes the *Science of Optics*. The observation of the peculiar effect produced by light on the constitution of some bodies, more particularly as regards obtaining impression of objects by those effects, has received the name of PHOTOGRAPHY.

The word *Photography* is derived from two Greek words, Θῶς and *Γραφω*, and is applied to the art of making pictures or impressions by the agency of light.

Light has been known for a long time to produce other effects besides that of illuminating objects, and rendering them visible to our senses; such, for instance, as destroying the colour from some bodies and increasing it in others. These effects are caused by and have received the name of the "CHEMICAL ACTION OF LIGHT," in the same way that heat and the cause of heat are generally called by one and the same appellation.

The *chemical action of light* is either to cause bodies to combine together or to decompose them, and the decomposing effect of light being generally in proportion to the facility with which the same result may be produced by other means, it is one of the chief endeavours of the Photographist to discover and employ those compounds whose constituents are held together by the least possible degree of affinity.

The compounds of silver are those which are generally used for photogenic or photographic purposes, and they appear, as far as our present knowledge extends, to be the most influenced by the action of light, although it is extremely probable, from some late experiments of Sir J. Herschel, that there is not a compound, of whatever nature it may be, but is affected more or less by light; and although that effect may not, in many instances, be visible, still it may exist, and only requires the substance which has been exposed to its action to be placed under different circumstances to make the effect apparent to our senses.

The darkening of recently precipitated chloride of silver, when exposed to the light, appears to have first suggested the idea of photographic drawing, and the earliest recorded experiments on this subject are those of Wedgwood and Sir H. Davy, which were published in the Journal of the Royal Institution, in June, 1802; but as these philosophers were not able to prevent the further action of light after the impression had been obtained, their experiments led to no conclusive result, and the subject was in a short time abandoned. M. Niepce, about the year 1814, appears to have been the next who turned his attention to the production of pictures by light; he continued his experiments alone for about ten years, when he became acquainted with M. Daguerre, who was also pursuing the same object. These two gentlemen continued their researches together, without publishing any of their results, till the beginning of 1839, when the discovery of *Daguerreotype* was announced; but the process was kept secret till the month of July in the same year, when the French Government purchased the secret.

In January, 1839, Mr. Fox Talbot, who had been experimenting for a considerable time to render paper sensitive to light, communicated to the Royal Society his photographic discoveries, and shortly afterwards published the mode of preparing his sensitive paper, and the method of obtaining photogenic drawings from leaves, flowers, feathers, &c. To Mr. Fox Talbot is due the honour, not only of having first given to the world his beautiful process of photogenic drawing, but also the more recent discovery of the *Calotype*, by which objects may be obtained on paper by means of the camera obscura, in a few seconds, and rivalling, in point of effect, the delicate outline of the Daguerreotype.

The photographic art is also greatly indebted to the interesting and valuable researches of Sir John Herschel, who has invented and suggested many improvements in known pro-

cesses, and likewise discovered the *Crysotype* and several other peculiar and beautiful modes of photogenic drawing. Among the many whose experiments have enriched this interesting subject, besides those already mentioned, the names of Fyfe, Hunt, Ponton, Donne, Draper, Becquerell, and Redman, will be sufficient to show the attention and science that have been and are devoted to perfect and simplify Photography ; but as we advance, wider appears the field, and more bright the prospect; and so fraught with interest and amusement is every department that has been yet explored, and so many still remain untouched, that we may anticipate results far greater than have yet transpired ; and it may not be chimerical to imagine that the time is not far off, when we shall be able faithfully to copy in a few seconds, the beautiful varied forms and colours of animate and inanimate Nature, whether in her sober guise, or decked in her gaudiest dress,

Even in its present state, the art must be invaluable to the traveller, enabling him, with only a slight addition to his usual equipment, to obtain correct copies from Nature's self of all objects of interest he may chance to meet. The botanist and naturalist are able to retain fac-similes of all those objects, whether flowers, leaves, trees, feathers, insects, or animals of any description, that interest them the most; these copies, in general, not only containing a correct outline, but sufficient detail to distinguish their distinctive characters. In fact, every one who either loves to copy Nature in her outward form by art, or to observe and trace her in her more obscure walk of science, must feel interested and delighted, and endeavour, as far as he possibly can, to enrich, by his own observation or experiment, so valuable and interesting a discovery, in which art and science go hand in hand.

CHAPTER II.

OPTICS.

The intention of the following description of the chief Optical Principles, as far as they relate to the formation of images, is to convey to the Photographist a correct idea of the action of lenses, and instruments constructed with them, so as to enable him to make as extended applications of the Photographic art as possible.

1. All instruments formed of one or more convex lenses produce, at a point called the focus, an image of all luminous objects towards which they are directed.

2. Whenever a sensitive surface is placed in the focus of one of these instruments, a copy of the object will be obtained, but this copy, or rather image, will be more or less clear in its detail—more or less bright, according to the perfection of the lenses and their relative position to the object.

3. Every image produced by a convex lens is reversed.

4. The size of the image is to that of the object, as the distance of the image to the lens is to that of the lens to the object.

5. All rays of light with which the Photographist has to deal with are diverging; nevertheless, to convey a clear idea of what ought to be understood by the term focus, it will be requisite to say a few words relative to the alteration that lenses produce on parallel rays.

6. When parallel rays of light fall on a convex lens, those which impinge on its axis do not undergo any alteration in passing through the glass, but follow their original direction; but all the others converge, after passing the lens, till they meet at a certain point of the axis, which point is called the focus.

Example.—The ray A (Fig. 1), which passes through the centre of the lens D, proceeds in a direct line, but the rays C D and E D are refracted and converge to a point F, situated upon the prolongation of the axis A F. The point F is termed the *principal focus*, or the *focus of parallel rays.*

7. When the rays are diverging they follow the law as shown in Fig 2. The rays A D A E diverging from the point A, and meeting the lens D E, whose *principal focus* is at B, are refracted by the glass, and converge towards the point F, where they intersect each other, and form an image of the point A.

8. If the lens be brought nearer to the radiating point A, the focus F will be lengthened, and *vice versa;* but these alterations, in the focal distance, follow certain rules.

9. Suppose the point A to be placed at G, a point equal to twice the principal focal distance C B, the focus F will be at H, as far behind the lens as the radiant point G is before it. If A be placed at I, the focus F will be infinitely distant, or the refracted rays will become parallel, and will not form an image; finally, if A be placed between I and C, the rays diverge after

refraction. Either of the points A or F may be considered as the focus, for if the radiant point be F, its image will be formed at A, in the same way that A will produce an image or focus at F; it is to this relation or interchange between the radiant points and foci that the term has been given of *conjugate foci*.

10. The formation of images in that well-known instrument, the *camera obscura*, is due to a convex lens placed in the front of the instrument. It has been mentioned, at sec. 3, that all images formed by a convex lens are reversed, and consequently inverted, now the reason of this, and also of the formation of an image, will be better understood by referring to Fig. 3. If A F B is an object placed before a convex lens L L, every point of it will send forth rays in all directions; but for the sake of simplicity, suppose only three points to emanate rays, one at the top, one at the middle, and one at the bottom, the whole of the rays then that proceed from the point A, and fall on the lens L L will be refracted and form an image somewhere on the line A C D, which is drawn direct through the centre of the lens, consequently the focus D, produced by the convergence of the rays proceeding from A, must form an image of A, only in a different relative position; the middle point F being in a direct line with the axis of the lens, will have its image formed on the axis G, and the rays proceeding from the point B will form an image as E; so, that by imagining luminous objects to be made up of an infinite number of radiating points, and the rays from each individual point, although falling on the whole surface of the lens, to converge again and form a focus or representation of that point from which the rays first emerged, it will be very easy to comprehend how images are formed, and the cause of those images being reversed.

It must also be evident, that in the two triangles A C B and E C D, that E D, the length of the image, must be to A B the length of the object, as C D, the distance of the image, is to C A the distance of the object from the lens.

11. This last rule will point out the method to be followed if images are required of a certain determinate size; for example, if C F was equal to C G, the image E D would be of the same size as the object A B; if C F was as long again as C G, the image would be half the size of the object; if, on the contrary, C F was half the length of C G, the image E D would be double the size of the object A B.

The knowledge of this principle is very important, inasmuch as it allows persons to determine beforehand the relative sizes of the image and object, and thus enables them to make

more extended applications of those instruments by means of which photographic pictures are obtained.

12. The next point that demands attention is the methods by which these may be rendered more bright.

If two lenses be used of the same focus, the images produced by one may be rendered much more brilliant than those produced by the other, by having the former of larger diameter; for instance, if one of the lenses was two inches, and the other one inch in diameter, the former would intercept four times the quantity of light more than the latter, and it is evident the image produced would be four times as brilliant.

Example.—The cone of light A B C, Fig. 4, would be entirely intercepted by the lens B C, while the lens D E would only intercept a small part; so, when it is not possible to increase the brightness of the object by illuminating it, the brightness of the image can always be increased by using a larger lens.

Care must be taken not to confound *brightness* with clearness; they are two things totally different, and the gaining of one does not in general depend upon the other; for it is necessary, in many cases, to stop a portion of light from falling on the lens, by which means a much sharper picture is obtained.

13. Hitherto, for the sake of conveying the first principles in as simple a manner as possible, reference has also been made to simple lenses; but these glasses are not sufficient for the purposes of science—both spherical and chromatic aberration render them unfit to produce those effects which are required from optical instruments.

14. *Spherical Aberration.*—So far it has been supposed that the rays refracted by simple lenses have their foci situated in the same plane; but in admitting that refraction takes place equally at every part of the lens, it is evident that those rays which are the most oblique, after being refracted, cannot intersect and form their focus in the same plane as those rays which are nearer the axis; and it is also certain that the latter suffer less refraction, and consequently converge less, and form their image at a greater distance; from which it follows, that as all the foci do not fall in the same plane, the image will be distinct only at certain parts.

Let A B, Fig. 5, be a plano-convex lens, and the rays C D E F emanating from the sun and falling parallel to G K on the flat surface of the glass, the rays D E, near the axis G K, will suffer less refraction than the rays C F, and will form a focus at K, whereas the extreme rays C F will form their

focus at H. How, then, is a perfect image to be obtained with this difference of focus ? If A H and B H are prolonged to L and M, where the rays meet the plane L M of the focus K, an image of the sun will appear surrounded with a luminous zone, to which the name of *Halo* has been given, and which will appear less brilliant the further it is removed from the centre K. The same reason is applicable to all the intermediate rays from C to D and F to E, and their different foci will fall between H and K.

16. It is very easy to verify the correctness of these rules, for if the surface of the lens be covered with a diaphragm having a central opening, so as to allow those rays only to pass which are near the axis, a clear and sharp image of the sun will be formed at K, and if, instead of the diaphragm a small disk be used, so as to intereept the central rays, an equally clear image of the sun will be formed at H. These two experiments go also to prove what has before been stated, for, in both cases, the image is rendered more sharp, but less luminous. The term longitudinal aberration is given to the distance H K, and that of lateral aberration to the width L M.

17. *Chromatic Aberration*.—To understand what is meant by chromatic aberration, it is necessary to bear in mind that light is decomposible, or, in other words, it is the result of a combination or mixture of a certain number of colours, which are considered as the elements of white light, because they have not yet been decomposed. These primitive colours are generally divided into seven classes, in the following order:—Red, orange, yellow, green, blue, indigo, and violet ; but, it is the opinion of Brewster and many other philosophers, that these seven may be reduced to three, viz. red, yellow, and blue, the other colours being formed by their overlapping each other. These colours can be shown by decomposing a ray of light—by means of a prism a coloured image will be formed, to which the term *spectrum* has been given. Seeing that prisms decompose white light, it follows that a lens, which amounts to nothing more than a union of prisms, ought equally to decompose all luminous rays which pass through it, and form coloured images of those objects from whence the rays emanated ; so when objects are viewed through a glass which is not achromatic, they appear surrounded by the colours of the rainbow.

18. All those colours which form a ray of white light are not equally refracted by lenses, and consequently cannot meet at the same focus and form a white ray; and not only does this fact explain the colouring of the image, but also the want of sharpness which it presents. The following example will, perhaps, render the foregoing more easy to be understood.

19. If L L, Fig 6, be a double-convex lens, and R L R L parallel rays of white light, composed of the seven coloured rays, each having a different index of refraction, they cannot be refracted to one and the same point; the red rays being the least refrangible will be refracted to *r*, the violet rays being the most refrangible to *v*; the distance *v r* constitutes the chromatic aberration, and the circle, of which the diameter is *a b*, the place or point of mean refraction, and is called the circle of least aberration. If the rays of the sun are refracted by means of a lens, and the image received on a screen, placed between *c* and *o*, so as to cut the cone L *a b* L, a luminous circle will be formed on the paper, only surrounded by a red border, because it is produced by a section of the cone L *a b* L, of which the external rays, L *a* L *b*, are red; if the screen be moved to the other side of *o*, the luminous circle will be bordered with violet, because it will be a section of the cone M *a*, M *b*, of which the exterior rays are violet. To avoid the influence of spherical aberration, and to render the phenomena of colouration more evident, let an opaque disk be placed over the central portion of the lens so as to allow those rays only to pass which are at the edge of the glass, a violet image of the sun will be seen at *v*, red at *r*, and finally images of all the colours of the spectrum in the intermediate space; consequently, the general image will not only be confused, but clothed with prismatic colours.

20. It must be evident, from what has been explained in the preceding sections, that to produce a good sharp image, both the spherical and chromatic aberration must be avoided; this can only be effected by a very nice adjustment of glasses of different forms and densities, and lenses so constructed are called *achromatic*.

CHAPTER III.

THE CAMERA OBSCURA.

The *Camera* is the most important of apparatus to the Photographist, inasmuch as the clearness and sharpness of the results obtained mainly depend upon its construction. The cheapest and best form of camera, where extreme sharpness is not required, as is the case when prepared paper is employed, is one fitted (as described by Dr. Wollaston in the *Phil. Tran.*

for 1812) with a meniscus lens, having the radii of its curves in the proportion of two to one. The form of camera is shown in section at Fig. 7.—It consists of a wooden box, in the front of which slides a tube, containing a meniscus lens, which has a diaphragm or stop placed a short distance in front of it; at the back of the camera slides a frame holding a piece of ground glass, for the purpose of ascertaining the focus, and also a frame so constructed that the prepared paper can be placed between a plate of glass and a smooth surface of slate; in the front of the glass is a slide to protect the paper from the action of light till introduced into the camera. In using cameras which have either meniscus or plain lenses, it must be borne in mind that the visual focus, as shown on the ground glass, will not give a sharp photographic picture, and the reason of this is very obvious—for those rays which produce a chemical action on any sensitive surface or material always accompany the violet rays of the spectrum; and, in describing Fig. 6, it has been shown that the violet rays form a focus *v* nearer to the lens than the point of least aberration *o*, where the picture would appear clearest to the eye; consequently, to obtain a sharp photograph, it would be necessary to shorten the distance between the lens and paper, so that it may be brought to that point where the violet and chemical rays form a focus. The distance the paper ought to be approximated to the lens, after ascertaining the optical or visual focus, will depend, in a great measure, upon the focal length of lens, and the distance of the object. The best plan to arrive at this point is to make one or two trials, and when the distance is once ascertained, mark the sliding tube. A modification of the foregoing has been suggested by Mr. Cundell, and will be found extremely useful for Calotype drawing; it is represented at Figs. 8 and 9. The chief novelty in this arrangement is the introduction of the diaphragms A B and C D, and in the elongation of the mouthpiece, both of which are useful in protecting the picture from all external light, except that which emanates from the objects to be copied, the rays from the direction *b* being intercepted at B, and those from *d* at D. The paper is placed between two plates of glass, contained in a frame, which fits the open end G H.

By reference to Fig. 9, it will be seen, that by means of the diaphragm, or "stop" E E, the rays from the barb of the arrow are excluded from the upper, and received only upon the lower half of the lens, at which they fall at a comparatively high and *equal* angle of incidence. They are thus less refracted than they would otherwise be, and their focus is not only sharpened, but elongated. By this means, the picture,

instead of being formed in the usual curve, is formed much nearer to a straight line in the plane of the paper placed to receive it.

10. A lens of twelve inches focus, which is the kind most recommended, ought to have an aperture of 2-4 inches. The diaphragm at E F (in which the principal virtue of the instrument resides) ought to be placed 1-5 inch in advance of the lens, and its opening ought not to exceed 1-2 inch. By using one of a smaller opening, a much finer image will be obtained, but at the sacrifice of light: at short distances, however, on account of the increasing divergency of the rays, only a small opening, admitting the mere centres of the pencils, can be used with advantage. The size of the plate glasses may be eight inches by six.

On the sliding part of the camera is placed a strip of wood or ivory, graduated for both the optical and chemical focus, so that the instrument can be set in an instant by merely measuring the distance of the object to be copied, if near, or by guessing at it, if out of reach.

When extreme fineness of detail is required, as is the case with the daguerreotype picture, an *Achromatic Camera* ought alone to be used.

For taking views, &c., where the time required in the operation is not of great moment, a single achromatic lens will answer every purpose, provided it has a stop properly placed in front of it, so as to cut off the side rays. A very convenient form of the instrument is shown at Fig. 10; it consists of a mahogany box, in the front of which is fixed a brass sliding tube, A, having an achromatic lens at one end, and the opening contracted, so as to form a stop at the other, as shown at B. In the front of the stop is a small shutter for opening or closing the aperture. At the back of the camera fits the ground glass for ascertaining the focus and frame for holding the prepared plate or paper.

There are two objections to the use of a *single* achromatic lens—viz., the time required to produce a picture in consequence of being obliged to cut off a great quantity of light, or otherwise the picture is not sharp—and the small field they give free from spherical aberration, especially if the focus is short. These objections have led to the invention of a compound lens of short focus, which will give a large picture, free from aberration, exceedingly sharp in its details, without the absolute necessity of using a stop. The great advantage of these compound lenses over all others is the rapidity of their action, inasmuch as the whole of the rays emanating from

an object are concentrated on the plate, whereas the single lens requires a large portion of them to be cut off.

Both Chevalier and Lerebours, in France, and Voigtlander, in Germany, have paid great attention to the construction of these compound lenses, and till lately were the only parties who could supply a compound lens properly manufactured. But now, in consequence of the great demand for the best description of lenses for photographic purposes, there has been great pains bestowed in England, both upon the manufacture of the glass of which the lenses are made, and also to ascertain the best curves, &c., to which they ought to be worked. The result has been the production of glasses equal in every respect, and, in many instances, superior to those imported from the continent, and at a much less cost. Fig. 11 gives a representation of a photographic camera fitted with one of the improved compound lenses, and Fig. 16 represents the lens in section, showing the disposition of the various glasses.

With either the single or compound lens, the focus is adjusted by rackwork, or by a simple sliding tube; and as the achromatic glass, if properly constructed, causes all the coloured rays to meet at one focus, the correct adjustment will be that point where the object is represented in the clearest and sharpest manner on the ground glass.

The form of camera represented at Fig. 13 has a mechanical contrivance at the back, whereby the relative position of the plate to the lens can be altered. This arrangement allows a glass of very short focus to be used, as the errors caused by various parts of the object to be copied being at different distances is, in a great part, remedied by altering the parallelism of the back frame and the object glass.

As all objects in the camera obscura appear reversed, that is, all right-hand objects will appear to the left in the picture, and *vice versa*, it is of great importance, in many instances, to obtain the pictures as they appear in nature; this is accomplished by the small reflecting mirror or prism, Figs. 17 and 18, which have the effect of again reversing the object in the camera, and thus rendering the picture correct. When used, they must be turned towards the object to be copied till a perfect representation is observed on the ground glass.

When the mirror or prism is employed, the time required to produce a picture is more than doubled.

CHAPTER IV.

PHOTOGENIC DRAWING.

This simplest branch of Photography appears to have been first suggested, as before mentioned, by Sir H. Davy, but was brought to apparent perfection by Mr. Fox Talbot in 1839, the principle of whose discovery was washing paper over with some preparation of silver that darkened in proportion to the intensity of light falling on its surface, and, when a sufficiently distinct image was produced, dissolving out the remainder of the silver preparation that had not been decomposed by the light, by which means a permanent impression was obtained.

The above is the principle upon which all the various photogenic compounds act. Above a hundred different modes and compounds are described in some works on this subject; but it is not the intention here to describe any but those processes which have generally been found the most successful.

SELECTION OF THE PAPER.

The kind of paper most recommended is that called blue wove post, or Whatman's writing paper, and those sheets only should be selected which appear of an even texture throughout and free from spots. This is best ascertained by holding the sheets of paper before a lamp; each sheet should have a pencil-mark made on one side, that the surface which has to be prepared may be distinguished when required.

PREPARATION OF THE PAPER.

The only apparatus necessary for this purpose are a few frames of wood similar to those used for slates, a little smaller than the sheets of paper to be prepared, two or three soft camel-hair brushes, some sheets of white blotting-paper, two or three glasses for holding the photogenic solutions, and one or two glass stirring rods. The chemical solutions required are a quarter of an ounce of crystallized nitrate of silver dissolved in two ounces of water, and forty grains of common salt, or muriate of ammonia, also dissolved in two ounces of water.

The paper to be prepared should be slightly damped by placing it for a short time between several folds of the blotting-

paper, previously wetted; a sheet should then be carefully pasted on one of the wooden frames, and allowed to dry; it may then be evenly washed over, by means of a camel's-hair brush, with the solution of nitrate of silver, taking care that the brush is used in one uniform direction over the sheet, removing it as seldom as possible, and avoiding the extreme edge of the paper pasted to the frame, which should not be wetted. The paper may then be allowed to dry in a dark place, and, when dry, washed over with the solution of muriate of soda or ammonia, observing the same precautions as recommended for applying the first solution of silver. When dry, the paper thus prepared may be cut out of the frame and kept for a considerable time, if preserved from the light, and as much as possible from the atmosphere.

MODE OF USING THE PHOTOGENIC PAPER.

This photogenic paper may be used for obtaining correct copies of all small objects, either of nature or art, provided they are, or can be made, sufficiently flat, without injury; the objects best adapted for this purpose are plants, leaves, flowers, ferns, mosses, feathers, wings of insects, prints, drawings, lace, and other similar articles. The only apparatus necessary will be two pieces of plate-glass, the size of the drawing, to be made—or a little larger, either separate or fixed in a frame, so contrived that the two plates may be pressed together by means of a screw or weight, and a thin deal board, covered with two or three folds of flannel, Fig. 32. To copy objects that are flat, such as prints, drawings, &c., proceed as follows:—Place a sheet of the photogenic paper on one of the pieces of plate-glass, taking care that the prepared side, which is easily distinguished by the mark made for that purpose, is upwards. The print or drawing should then be placed on the paper, printed side downwards, and a small particle of wafer or gum applied at one of the corners, so as to attach it to the prepared paper; the other piece of plate-glass is now to be placed so as to press them into close contact. The whole may then be exposed to the light, the drawing to be copied being upwards.

The time required to produce an impression depends, in a great measure, upon the thickness of the paper upon which the print or drawing is made; about ten minutes in a bright sunshine, or half an hour clear daylight, is generally sufficient; but the best method is to gently slide the upper glass partially off, without disturbing the position of the print or drawing; and by carefully lifting that part which is uncovered by the

glass, see whether the impression is complete; if not sufficiently dark, return the glass to its place, and expose it some time longer to the action of the light, till the copy be sufficiently distinct.

To copy objects that are not flat, such as plants, leaves, butterflies, &c. &c., proceed as just described, but interpose between the lower glass and the prepared paper, which should be slightly damped, the board covered with flannel, and apply a moderate pressure to the upper glass, by which means the object will be slightly embedded in the sensitive paper, and a very beautiful and correct impression obtained.

If the object be very unequal in its thickness at certain points, those parts may, in most cases, be reduced by means of a penknife, without impairing, in the slightest degree, the accuracy or effect of the copy.

There are many ways of modifying the process for obtaining photogenic drawings, from various substances and articles, which cannot fail to occur to the experimenter, and, therefore, need not be particularly described; such, for instance, as covering a piece of glass with a coating of some opaque substance, as a mixture of lamp-black and varnish, and tracing a subject through it with a point. If the glass thus prepared be then laid on a sheet of photogenic paper, and exposed to the light, an impression will be obtained somewhat similar in appearance to a line engraving, or pen and ink drawing.

FIXING THE PHOTOGENIC DRAWING.

When an impression has been obtained by any of the means just described, it is necessary, for its preservation, that the undecomposed salt of silver remaining in the paper be removed.

The best article for this purpose is the salt called hyposulphite of soda, one ounce of which is to be dissolved in one pint of water. This solution, when about to be used, should be poured into a flat dish of sufficient size to contain the photogenic drawing to be fixed.

Immediately after a drawing has been obtained, it should be washed in plain water, and partially dried between some folds of blotting-paper; it ought then to be laid into the solution of hyposulphite of soda for a minute or so, and afterwards well washed in separate portions of water till the water comes off tasteless; the picture is now perfectly fixed, and

may be dried and exposed to the light without any risk of injury.

The *rationale* of this fixing process is this : The chloride of silver, which is the result of the preparation of the paper, is very soluble in hyposulphite of soda; whereas, the sub-chloride of silver reduced by the light is not; the consequence is, that when the photogenic impression is placed in the hyposulphite, all the undecomposed chloride of silver is converted into hyposulphite of silver, which, being very soluble in water, is removed by the subsequent washing.

The hyposulphite of silver having a very sweet taste, which it communicates to a large quantity of water, affords the best criterion for judging when the paper has been sufficiently washed in the fixing process just described.

NEGATIVE AND POSITIVE PHOTOGRAPHS.

A photographic impression obtained by the ordinary photogenic paper will, of course, have the light and shades reversed in regard to the original, *i. e.* the light parts of the original will allow the light to pass through, and produce shades on the paper, whereas those parts which are thick or opaque, by obstructing the light, will remain white, or nearly so. These kinds of impressions are called *negative* ones, in distinction to those pictures where the lights and shades are as in Nature, when they are called *positive* photographs.

A photogenic copy of a print, for example, will, in the first instance, be a negative one; and in order to obtain a positive picture, or correct copy of the original, it must be reversed. This can be done by exactly the same means as were used for obtaining it in the first instance, only substituting the negative drawing for the print. In this way any number of positive copies may be obtained from one negative picture.

CHAPTER V.

THE CALOTYPE.

The word *Calotype* is derived from two Greek words, signifying "beautiful picture, or image." The Calotype, or as it is sometimes called Talbotype process, for taking pictures on paper, has been patented in this country, by Mr. Fox

Talbot, in whose specification it was first described; it differs, in one respect, from all the former photogenic processes, inasmuch as the image formed on the calotype paper is quite invisible when taken from the camera, until washed over with a liquid containing gallic acid, or, as recently discovered by Mr. Hunt, a small quantity of a solution of proto-sulphate of iron, when the picture gradually appears in all its details. In this particular the beautiful process bears a remarkable analogy to the daguerreotype.

The following excellent description of the process, with some improvements recently suggested by Mr. Cundell, is extracted from a paper of his in the *Philosophical Magazine* for May, 1844, and will be found very effective and simple:

1. To produce a calotype picture there are five distinct processes, all of which, except the third (§ 12), must be performed by candle-light; they are all very simple, but at the same time all of them require care and attention. The first, and not the least important, is

2. *The Iodizing of the Paper.*—Much depends upon the paper selected for the purpose; it must be of a compact and uniform texture, smooth and transparent, and of not less than medium thickness. The best I have met with is a fine satin post paper, made by "R. Turner, Chafford Mill." Having selected a half sheet without flaw or water-mark, and free from even the minutest black specks, the object is to spread over its surface a perfectly uniform coating of the iodide of silver, by the mutual decomposition of two salts, nitrate of silver and iodide of potassium. There is a considerable latitude in the degree of dilution in which these salts may be used, and also in the manner and order of their application; but as the thickness and regularity of the coating depends upon the strength of the solution of nitrate of silver, and upon the manner in which it is applied, I think it ought by all means to be applied first, before the surface of the paper is disturbed. I use a solution of the strength of seventeen grains to the ounce of distilled water.

3. The solution of silver is to be poured into a shallow pan, of sufficient size to admit the sheets of paper to be prepared, each of which should have about one quarter of an inch turned up at each end; then taking one turned-up edge in each hand, bring the surface of the paper in contact with the nitrate of silver, so that its whole surface may be evenly wetted; when this is done, place it on a clean board with its wet surface upwards, and in a dark room or box till dry. Another

plan is to pin the sheet of paper by its two upper corners to a clean dry board, a little larger than itself; and, holding this nearly upright in the left hand, and commencing at the top, apply a wash of the nitrate of silver *thoroughly, evenly,* and *smoothly* with a large soft brush, taking care that every part of the surface be thoroughly wetted, and that nothing remain unabsorbed in the nature of free or running solution. Let the paper now hang loose from the board into the air to dry, and by using several boards time will be saved.

4. The nitrate of silver spread upon the paper is now to be saturated with iodine, by bringing it in contact with a solution of the iodide of potassium; the iodine goes to the silver and the nitric acid to the potash.

5. Take a solution of the iodide of potassium of the strength of 400 grains to a pint of water, to which it is an improvement, analogous to that of M. Claudet in the daguerreotype, to add 100 grains of common salt. He found that the chlorinated iodide of silver is infinitely more sensitive than the simple iodide; and by this addition of common salt, a similar, though a less remarkable, modification is obtained of the sensitive compound. Pour the solution into a shallow flat-bottomed dish, similar to the one used for applying the nitrate of silver, and let the bottom of the vessel be covered to the depth of an eighth of an inch. The prepared side of the paper having been previously marked, is to be brought in contact with the surface of the solution. Holding by the upturned margin, the paper is to be gently drawn along the surface of the liquid, until its lower face be thoroughly wetted on every part; it will become plastic, and in that state may be suffered to repose for a few moments in contact with the liquid; it ought not, however, to be exposed in the iodine dish for more than a minute altogether, as the new compound, just formed upon the paper, upon further exposure would gradually be re-dissolved. The paper is therefore to be removed, and, after dripping, it may be placed upon any clean surface, with the wet side uppermost, until about half dry, by which time the iodine solution will have thoroughly penetrated the paper, and have found out and saturated every particle of the silver, which it is quite indispensable it should do, as the smallest portion of undecomposed nitrate of silver would become a black stain in a subsequent part of the process.

6. The paper is now covered with a coating of the iodide of silver; but it is also covered, and indeed saturated, with saltpetre and with the iodide of potassium, both of which it is indispensable should be completely removed. To effect the

removal of these salts, it is by no means sufficient "to dip the paper in water;" neither is it a good plan to wash the paper with any considerable motion, as the iodide of silver, having but little adhesion to it, is apt to be washed off. But the margin of the paper being still upturned, and the unprepared side of it kept dry, it will be found that by setting it afloat on a dish of clean water, and allowing it to remain for five or ten minutes, drawing it gently now and then along the surface, to assist in removing the soluble salts, these will separate by their own gravity, and the iodide of silver being insoluble in water, nothing will remain upon the paper but a beautifully perfect coating of the kind required.

7. The paper is now to be dried; but while wet, do not on any account touch or disturb the prepared surface with blotting-paper, or with anything else. Let it merely be suspended in the air, and, in the absence of a better expedient, it may be pinned across a string by one of its corners. When dry it may be smoothed by pressure. It is now "iodized" and ready for use, and in this state it will keep for any length of time. The iodized paper by keeping loses a considerable degree of its sensitiveness, but is capable of being restored to its original state by being exposed for a short time to the direct action of the sun. The second process is that of exciting, or—

8. *Preparing the Paper for the Camera.*—For this purpose are required the two solutions described by Mr. Talbot, namely, a saturated solution of crystallized gallic acid in cold distilled water, and a solution of the nitrate of silver, of the strength of fifty grains to the ounce of distilled water, to which is added one-sixth part of its volume of glacial acetic acid. The gallic acid solution will not keep for more than a few days, and only a small quantity therefore should be prepared at a time. When these solutions are about to be applied to the iodized paper, they are to be mixed together, in equal volumes, by means of a graduated drachm tube. This mixture is called "the gallo-nitrate of silver." For many purposes these solutions are unnecessarily strong, und unless skilfully handled they are apt to stain or embrown the paper; where extreme sensitiveness therefore is not required, they may with advantage be diluted with water, in which state they are more manageable and nearly as effective. As the gallo-nitrate speedily changes, and will not keep for more than a few minutes, it must be used without delay, and it ought not to be prepared until the operator is quite ready to apply it. The degree of dilution must in a great measure depend upon the judgment of the operator, and should be proportioned to the brightness of the

day or brilliancy of the object. If the day be very dull, or the object to be copied much in shade, the gallo-nitrate may be used of the full strength, but if the day be bright or the objects illuminated by the sun, then it should be diluted with from ten to twenty times its bulk of water.

9. The application of this "gallo-nitrate" to the paper is a matter of some nicety. It will be found best to apply it in the following manner:—Pour out the solution upon a clean slab of plate glass, diffusing it over the surface to a size corresponding to that of the paper. Holding the paper by a narrow upturned margin, the sensitive side is to be applied to the liquid upon the slab, and brought in contact with it, by passing the fingers gently over the back of the paper, which must not be touched with the solution.

10. As soon as the paper is *wetted* with the gallo-nitrate, it ought instantly to be removed; five or ten seconds at the most is as long as it is safe at this stage to leave the paper to be acted upon by the gallo-nitrate; in that space of time it absorbs sufficient to render it exquisitely sensitive. The excess of gallo-nitrate must immediately be removed by a sheet of fine blotting paper, free from water-mark, laid over its surface and very lightly pressed. It may now be dried in the dark, in the manner described in § 7, or, what is better, it may be placed, while still damp, in the camera frame between the white glasses ready for use, by which it is protected as much as possible from the action of the atmosphere. If properly prepared, it will keep perfectly well for four-and-twenty hours, at least, preserving all its whiteness and sensibility.

11. The light of a single candle will not injure the paper at a moderate distance, but the less the paper, or the exciting solution, is unnecessarily exposed, even to a feeble candle-light, the better. Common river or spring water answers perfectly to *wash* the paper, distilled water being required for the silver solutions only. Stains of "gallo-nitrate," while recent, may be removed from the fingers by a little strong ammonia, or by the cyanide of potassium. The third process is that of —

12. *The Exposure in the Camera.*—For which, as the operator must be guided by his own judgment, few directions can be given, and few are required. He must choose or design his own subject, he must determine upon the aperture to be used, and judge of the time required, which will vary from a few seconds to three or four minutes. The subject ought, if possible, to have a strong and decided effect; but extreme

lights, or light-coloured bodies in masses, are by all means to be avoided. When the paper is taken from the camera, very little, or more commonly no trace whatever, of a picture is visible, until it has been subjected to the fourth process, which is—

13. *The bringing out of the Picture,*—Which is effected by again applying the "gallo-nitrate" in the manner directed in § 9 only for this purpose it should be of its full strength. As soon as the paper is wetted all over, unless the picture appears immediately, it is to be exposed to the vapour of hot water, or to the radiant heat from an iron, or any similar body, held within an inch or two by an assistant. It ought to be held vertically as well as the paper; and the latter ought to be moved so as to prevent any one part of it becoming dry before the rest.

As soon as the picture is sufficiently brought out, wash it immediately in clean water to remove the gallo-nitrate; it it may then be placed in a dish by itself, *under* water, until you are ready to fix it. The most perfect pictures are those which "come out" before any part of the paper becomes dry, which they will do if sufficiently impressed in the camera. If the paper be allowed to dry before washing off the gallo-nitrate, the lights sink and become opaque, and if exposed in the dry state to heat, the paper will embrown; the drying, therefore, ought to be *retarded* by wetting the back of the paper, or the picture may be brought out best by the vapour from hot water placed at the bottom of rather a deep dish, or by a horizontal jet of steam. The fifth and last process is—

14. *The Fixing of the Picture,*—Which is accomplished by removing the sensitive matter from the paper. The picture, or as many of them as there may be, is to be soaked in warm water, but not warmer than may be borne by the finger; this water is to be changed once or twice, and the pictures are then to be well drained, and either dried altogether or pressed in clean and dry blotting-paper, to prepare them to imbibe a solution of the hyposulphite of soda, which may be made by dissolving an ounce of that salt in a quart (forty ounces) of water. Having poured a little of the solution into a flat dish, the pictures are to be introduced into it one by one; daylight will not now injure them. Let them soak for two or three minutes, or even longer if strongly printed, turning and moving them occasionally. The remaining unreduced salts of silver are thus thoroughly dissolved, and may now, with the hyposulphite, be entirely removed, by soaking in water and

pressing in clean white blotting-paper alternately ; but if time can be allowed, soaking in water alone will have the effect in twelve or twenty-four hours, according to the thickness of the paper. It is essential to the success of the fixing process that the paper be, in the first place, thoroughly penetrated by the hyposulphite, and the sensitive matter dissolved ; and next, that the hyposulphite compounds be effectually removed. Unless these salts are completely removed they induce a destructive change upon the picture, they become opaque in the tissue of the paper, and entirely unfit for the next, which is—

15. *The Printing Process.*—The picture being thus fixed, it has merely to be dried and smoothed, when it will undergo no further change. It is, however, a *negative* picture ; and if it has cost some trouble to produce it, that trouble ought not to be grudged, considering that you are now possessed of a matrix which is capable of yielding a vast number of beautiful impressions. I have had as many as fifty printed from one, and I have no doubt that as many more might be obtained from it.

16. The manner of obtaining these impressions has been so often described, and there are so many different modes of proceeding, that it may be sufficient to notice very briefly the best process with which I am acquainted. Photography is indebted for it to Mr. Alfred Taylor, the eminent chemist. His solution is made by dissolving one part of nitrate of silver in twelve of distilled water, and gradually adding strong liquid ammonia until the precipitate at first produced is at length *just* re-dissolved. This solution I dilute with two parts of water.

17. Some paper is to be met with containing traces of bleaching chlorides, which does not require any previous preparation ; but in general it will be found necessary to prepare the paper, by slightly impregnating it with a minute quantity of common salt. This may be done by dipping it in a solution in which the salt can be barely tasted, or of the strength of from thirty to forty grains to a pint of water. The paper, after being pressed in clean blotting-paper, has merely to be dried and smoothed, when it will be fit for use.

18. The ammonio-nitrate of silver is applied to the paper in the manner described in § 3, and when perfectly dry, the negative picture to be copied is to be applied to it, with its face in contact with the sensitive side. The back of the negative picture being uppermost, they are to be pressed into close contact by means of a plate of glass, and, thus secured, they are to be exposed to the light of the sun and sky. The exposed parts of the sensitive paper will speedily change to lilac, slate blue, deepening towards black ; and the light,

gradually penetrating through the semi-transparent negative picture, will imprint upon the sensitive paper beneath a *positive* impression. The negative picture, or matrix, being slightly tacked to the sensitive paper by two mere particles of wafer, the progress of the operation may from time to time be observed, and stopped at the moment when the picture is finished.

19. It ought then, as soon as possible, to be soaked in warm water, and fixed in the manner described in § 14.

20. In these pictures there is a curious and beautiful variety in the tints of colour they will occasionally assume, varying from a rich golden orange to purple and black. This effect depends in a great degree upon the paper itself; but it is modified considerably by the strength of the hyposulphite, the length of the time exposed to it, by the capacity of the paper to imbibe it, and partly, perhaps, by the nature of the light. Warm sepia-coloured pictures may generally be obtained by drying the paper, by pressure, and making it imbibe the hyposulphites supplied in liberal quantity.

The paper of "I. Whatman, Turkey Mill," seems to give pictures of the finest colour, and, upon the whole, to answer best for the purpose.

If the chemical agents employed be pure, the operator, who keeps in view the *intention* of each separate process, and either adopting the manipulation recommended, or improving upon it from his own resources, may rely with confidence upon a satisfactory result."

This calotype paper is so exceedingly sensitive to the influence of light, that very beautiful photogenic copies of lace, feathers, leaves, and such like articles, may be made by the light of a common coal gas flame, or an Argand lamp. The mode of proceeding is precisely that described for obtaining the ordinary photogenic drawings by daylight, only substituting the calotype paper, which should be damp, for the common photogenic.

When exposing the prepared paper to the light, it should be held about four or five inches from the flame, and the time required will be about three minutes.

By some late experiments of Mr. Maskelyne, it appears that the most sensitive Calotype paper is made by adding 100 grains of the bromine of potassium to the proportions of iodide and common salt, mentioned at § 5, for the first preparation of the paper, all the subsequent processes being the same as described.

CHAPTER VI.

DAGUERREOTYPE.

The Daguerreotype is a process by which correct copies of objects can be made from nature on polished surfaces of silver. It derives its appellation from its inventor, M. Daguerre, an ingenious French artist, who published the process in August, 1839, for which he, together with M. Niepce, who assisted him in his investigations, received the grant of an annuity from the French Government.

The process has been patented in England by Mr. Berry, in 1839, and in his specification is called "A new and improved Method of obtaining the spontaneous reproductions of all the images received in the focus of the Camera Obscura;" since which time it has been greatly improved, and still is improving in many particulars, especially as regards its simplicity and quickness of action.

DESCRIPTION OF THE PROCESS.

Daguerreotype pictures, as they are called, are taken on copper-plates, covered with a coating of silver, which should be as pure as possible, and of sufficient thickness to allow of its being very finely polished. A superior description of Sheffield plate is the kind generally used, which, after being cut to the sizes required, is flattened or planished by the hammer, and afterwards polished on a lathe to the required surface. These plates, properly prepared, and cut to any size, can be obtained ready for use.

The method of proceeding consists of five distinct operations, viz.—

1. Cleaning the silvered plate.
2. Rendering its surface sensitive to light, by exposing it to the vapour of iodine, bromine, or their combinations with chlorine, &c.
3. Exposing the prepared sensitive plate to the focus of either a refracting or reflecting camera.
4. Bringing out the picture by exposing it to the vapour of mercury.
5. Setting the picture, by removing the sensitive surface of the plate which has not been acted upon by the light.

1, *Cleaning the Silvered Plate.*—The object in this operation being to obtain a surface of silver perfectly pure and polished, it is of the greatest consequence that the articles used in the latter part of the process should be free from grease, or any other article of a fixed oily nature. Many ways and substances have been proposed for giving the best surface and polish, but the following can be recommended for its simplicity and the good result obtained.

The articles necessary for this operation are—

Cotton wool.
Calcined tripoli.
Prepared lamp black.
Olive oil.
Nitric or acetic acid diluted with about sixteen parts by measure of water.
Spirit-lamp and stand.
Pair of pliers.
Cotton velvet buff.

The cotton wool should be clean and free from any greasy substance, and if any difficulty is experienced in obtaining it so, it is best to prepare it by soaking for about an hour in a rather weak solution of ammonia (hartshorn), and, after thoroughly washing in clean water, allowing it to dry before the fire, or in a moderately heated oven.

The calcined tripoli, which should be in the state of an impalpable powder, is best kept for use tied up in a small muslin bag, and protected from dust in a wood or paper-box.

The lamp black should be prepared by making it red hot, in a crucible, till vapours cease to arise from it, the crucible may then be removed from the fire, closely covered up, and allowed to get cold. The lamp black thus burnt should be reduced to a fine powder in a glass or porcelain mortar, and a portion tied up, like the tripoli, in a small bag of very fine muslin.

The mode of proceeding is as follows:—Lay the plate, silver-side upwards, upon a piece of clean white paper, or what is more convenient and better, on the plate holder, Fig. 23, and shake a small quantity of the tripoli over it; a few drops of olive oil should then be applied, and with a knot of the cotton and a light hand proceed to polish the plate by a series of circular movements equally over its surface, adding more tripoli as required. The time usually expended for pro-

ducing a good surface on a new plate is about two minutes. If the plate be one that has been used, it should be heated over a spirit-lamp for a short time before beginning to polish. When a good surface is obtained, take a fresh pledget of wool, and, shaking more tripoli over the plate, gradually wipe off the oil, using a fresh piece of cotton as required. When the whole of the oil is apparently removed, the plate ought to be heated over a spirit-lamp till a white film is observed to form on the surface: it may then be allowed to cool; when cold, apply, by means of a piece of cotton-wool, a few drops of the dilute acid over the plate, which will immediately indicate if it has been sufficiently heated, by its flowing easily over its surface, without running into distinct globules, which it would otherwise do: if the acid wets the surface easily, dust a little tripoli over it, and with a fresh piece of cotton-wool dry the acid off in the same manner as you did the oil: if the acid does not adhere to the plate, it will require to be rubbed with the tripoli for a little longer time before drying off.

If the plate to be polished be very free from scratches or other blemishes, and has not been set with chloride of gold, the use of the oil can be dispensed with, and alcohol and tripoli alone used, as recommended by M. Lerebours.

For giving the plate its final polish, dust a little of the prepared lamp black on the velvet rubber or buff, and briskly polish, holding the plate, if a small one, on the plate-holder or the ends of the fingers of the left hand, and using the buff with the right; if a large plate, place its face downwards on the rubber, moving the plate up and down by means of the fingers, with a slight degree of pressure, taking care that for portraits the movement should not be in the direction of the face, but across it; and for views, in the direction of the view.

M. Daguerre has lately recommended the employment of oil of lavender for polishing; he dispenses with heating the plate, and merely spreads a drop of the oil over its surface, by means of a piece of cotton, then sprinkles some tripoli over it, and after polishing for one or two minutes, dries off the plate with a fresh piece of cotton, giving the last polish with the velvet buff. M. de Brebisson recommends mixing a certain quantity of dried tripoli with the bottle of oil of lavender, and after well agitating them together, pour out one drop, which will be found sufficient to polish a three inches by four plate.

The most important precaution to be attended to in the foregoing process is, that the polishing powder and buff should be perfectly free from damp; if there be any doubt on this point,

it will be advisable to place them, well protected from dust, before a fire, a short time previous to using.

2. *Applying the Sensitive Coating.*—When the plate is well polished it will appear perfectly black, on looking at it in a certain angle; and just before proceeding to expose it to the fume of iodine, be careful to remove every particle of dust or tripoli from its surface by a piece of prepared wool, or a very soft camel's-hair brush or clean velvet brush; if this is not attended to, a number of black specks will be seen on the plate when iodined.

The operation of iodizing divides itself into two parts—first, iodizing, properly so called; second, exposure to the vapour of some combination of bromine, chlorine, or iodine.

1st. *Iodizing.*—This is best accomplished by means of the apparatus represented at Fig. 16.* If the more simple form is used, as in Fig. 24, a small quantity of a solution of half an ounce of pure iodine in about an ounce and a half of sulphuric ether should be poured over the card at the bottom of the box, and spread evenly over its surface with a soft brush; in a few seconds the ether evaporates, leaving a coating of iodine. If not used immediately, the plate of glass placed over the card will, in a great measure, prevent the useless evaporation of the iodine.

To Iodine the Plate.—Remove the lid and plate of glass, and place it, face downwards, on the ledge for that purpose on the top of the box; in about a minute or two, according to the temperature, the plate will become of a fine orange yellow colour. It is well to examine it several times during this operation, to see that the iodine is spreading evenly over its surface, as it will sometimes happen that the evaporation proceeds more rapidly from one part than another, in which case the plate should have its position altered from time to time, that an even coating may be obtained over its surface.

The colour of the plate is observed by holding a sheet of white paper in such a position that its reflection may be seen on the plate, which will enable you to judge of the progress of the operation; if not sufficiently coloured, return the plate immediately to the iodine-box till the proper tint be obtained.

Another very excellent plan for giving an even coating of iodine to the plate, is to use a very dilute solution of chloride of iodine, two or three drops to the ounce of water; a small

* See description of cuts.

quantity of this solution should be poured into a shallow vessel, similar to the bromine pan (Fig. 25.),* and the plate subjected to its vapour till it assumes its proper colour.

The plate iodized by either the foregoing processes should be shut up in a dark box till wanted for use, when it must be subjected to one or other of the following processes :—

2. *Exposure to the Vapours of some combination of Chlorine, Bromine, or Iodine.*—All of these articles, separately, and their compounds, have been recommended at different times, by various persons, for giving to the plate its greatest degree of sensibility; the most simple and effective compound, according to the latest experiments on the subject, appears to be "bromide of iodine." But as many excellent daguerreotypists prefer and recommend other compounds, the method of applying the most effective of them has been added.

The best and most convenient form of apparatus for applying both the iodizing and sensitive solutions is represented at Fig. 26; the polished plate is placed, face downwards, in a frame sliding along the top of the box, which is divided by a partition, on each side of which is a square glass vessel with a moveable glass lid. The plate is first placed over the vessel containing the iodizing material, and the sliding glass lid is removed; the plate being thus exposed to the fumes of the iodine, changes colour as before described, and which can be observed without removing the plate by the small moveable mirror in front of the box. When the plate has attained its proper colour, the plate-glass lid is returned to its place, and the frame, containing the plate slid past the partition in the box over the pan containing the sensitive mixture, which is applied in the same manner as the iodine. The great advantage of this form of apparatus over all others is, that the plate is constantly under your eye, and the operation can be immediately stopped by sliding in the glass lids.

BROMIDE OF IODINE.

This is prepared, according to M. de Valicours, in the following manner :—Into a bottle of the capacity of about 2 ozs., pour 30 or 40 drops of bromine, the precise quantity not being of importance. Then add, grain by grain, as much iodine as the bromine will dissolve, till quite saturated. This point is ascertained when some grains of the iodine remain undissolved. They may remain in the bottle, as they will not interfere with the success of the preparation.

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* See description of cuts.

The bromide of iodine thus prepared, from its occupying so small a space, can very easily be carried, but in this state it is much too concentrated to be used. When it is to be employed, pour a small quantity, say 15 drops, by means of a dropping tube, into a bottle containing about half an ounce of filtered river water. It will easily be understood that the bromide of iodine can be used with a greater or less quantity of water, without altering the proportion which exists between the bromine and iodine. The above proportion has been given because it appears the most convenient for quickly preparing the plates, and the mixture also retains its uniformity of action for a considerable length of time.

The mixture of bromide of iodine and water, which has just been described, has all the properties of the bromine water, and according to the observations of M. Buron, will produce pictures, whatever tint of iodine may be employed, provided that the time of exposure above the bromide is *proportionate* to the quantity of iodine previously observed by the plate. Nevertheless, the following appear to be the most favourable tints for iodizing: a deep yellow (just changing to the rose), a bright rose, and a very dark rose or violet.

The plate should be iodized equally of one of these colours, then pour into the bromine vessel a quantity of the diluted bromide of iodine *just* sufficient to cover all the bottom. Allow it to remain about a minute, and then place the plate over the vessel, and judge when it has absorbed sufficient bromide, by counting the number of seconds.

It is easy to understand that the time the plate is exposed to this evaporation ought to vary according to the strength of the bromide, the depth or capacity of the vessel, and lastly, according to the size of the plates. However, the following will be found a very near approximation to the time required, and quite a sufficient guide, if some regard is paid to the circumstances just pointed out.

For a plate iodized to a deep yellow, 30 to 40 seconds; for a plate of a bright rose, 40 to 50 seconds, and the violet 50 to 65 seconds.

The time required for the plate to be exposed to the evaporation of the bromide can always be regulated at pleasure, by adding to the mixture either water or some *concentrated* bromide.

Those persons who are in the habit of examining the colour of the plates, can employ this method with the bromide of iodine: a plate iodized of a deep yellow, ought to be exposed

till it assumes a bright rose colour; if iodized to a rose, it should be brought to a violet tint, and if iodized to a violet, it should be changed to an intense *blueish green* colour.

It is well at first to observe the colour, and thus determine once for all, the time requisite for the plates to be exposed above the bromide. This can easily be done by counting seconds, and examining the plate from time to time, and when it has attained the desired tints, recalling the number of seconds during which it was exposed to the vapour. It will be sufficient afterwards to prolong the operation for the same space of time, without being obliged to examine the colour, for when once the dose of bromide required is ascertained, it will remain constant in its action for a considerable length of time.

When the effect of the measure appears to diminish, it can easily be restored by adding one or two drops of the concentrated bromide.

Exposure of the plate for some seconds, more or less, is not of vital importance to the success of the operation, for in proportion as the plate becomes charged with bromine, it deposits, at the same time, a proportionate quantity of iodine, and thus a proper balance always exists between the two substances. This property renders it of great advantage for persons yet inexperienced in daguerreotype manipulation.

Although pictures may be obtained equally rapid, whatever colour the plate is iodined, still the deep yellow and pale rose, appear to give the best results, after being properly bromined. The violet tints produce pictures of a pleasing tone, but slightly clouded. When iodized a light yellow, the results are usually of a blueish tint and solarized.

The quantity of bromide employed in the bromine vessels will last a considerable length of time without being renewed, if it be poured, at the end of each series of operations into a well stopped glass bottle.

CHLORIDE OF IODINE.

The accelerating action of Chloride Iodine was discovered by Mr. Claudet; this substance, although less rapid in its action than many at present known, still produces a very certain effect, and is very simple in its application.

A quantity of chloride of iodine is poured into a large glass bottle, having a large mouth, and after the plate is iodized of

a pale yellow tint, it is moved about over the bottle for some seconds so as to spread the vapours equally over its surface; then returned to the iodine box for a few seconds, and lastly shut up in the dark box, till wanted to be placed in the camera. If the vapours which escape from the bottle annoy the operator, it will be found a better plan to place a drop of the chloride at the bottom of a drinking glass, putting over it a small piece of carded cotton, and then place the plate on the upper part of the glass. By this plan less of the chloride will be lost, without so much risk of staining the plate, and less disagreeable vapours will be respired.

BROMINE WATER.

The following practical details, for the use of Bromine Water, are extracted from a Pamphlet on that subject by M. Fizeau.

When an iodized plate is exposed to the vapour of bromine, it is absorbed, and there results a coating of which the sensibility increases with the quantity of bromine absorbed up to a certain limit, beyond which no image will be formed under the influence of mercury. The most favourable point for operating is near this limit;—too near, the picture becomes indistinct; too far off, its sensibility is diminished. It is necessary, then, to determine this point with precision, and to obtain it with regularity, which presents some difficulties.

At all events, recourse cannot be had to the colour of the sensitive coating, which changes very slightly under the influence of bromine; the orange yellow colour of the plate certainly does change a little by the formation of bromide, but the colour of a plate bromined to the correct point, and that of a plate which has passed the limit of which I have spoken, differ so little, that by this means, the quantity of bromine absorbed, and consequently the sensibility of the plate can only be judged of in a very uncertain manner.

The method I propose is exempt from this cause of uncertainty; it consists in exposing the plate to the vapour of an aqueous solution of bromine of a certain strength, during a certain time. The following is the method in detail: —

1. *The Solution of Bromine.*—To prepare a solution of Bromine, of a fixed proportion and convenient strength to operate with, I, in the first place, make a saturated solution of bromine in water; this is prepared by putting into a bottle of pure water a great excess of bromine, agitating strongly for some

minutes, and before using allow the bromine well to separate.* Now a definite quantity of this saturated water is to be mixed with a definite quantity of plain water, which will give a solution of bromine always of the same strength. This mixture is conveniently made in the following manner: The apparatus necessary is a *dropping tube*,† which is also required for another part of the process, capable of holding a small definite quantity, and a bottle, having a mark to indicate a capacity equal to 30 times that of the dropping tube; fill the bottle with pure water to the mark, then add, by means of the dropping tube, the proper quantity of the saturated solution of bromine.

The purity of the water is of some importance; the foregoing proportions refer to pure distilled water, and it is well known that the water of rivers and springs is not pure; but these different varieties can be used as absolutely pure water by adding a few drops of nitric acid till they taste slightly acid; two or three drops to the pint is generally sufficient.

The liquid produced, which is of a bright yellow colour, ought to be kept in a well stopped bottle; it is the normal solution, and I shall call it simply bromine water, to distinguish it from the saturated solution.

II. *Bromine Box.*—The box I employ for subjecting the plate to the vapour of the bromine water, is constructed in the following manner:—‡

It consists of a box lined with a varnish which is not acted on by bromine; its height is about 4 inches; the other dimensions are regulated by the size of the plate, which ought to be at least half an inch all round, short of the sides of the box; it is composed of three separate portions; the cover, which is the frame holding the plate, the body of the box. and the bottom upon which is placed the vessel for the bromine; this moveable bottom is slightly hollowed, so that the bromine vessel may always be placed in exactly the same position.

The bromine vessel ought to be perfectly flat at the bottom rather shallow, and of such a size that it may at least be equal to half the surface of the plate; it should also be furnished with a cover of plate glass, so as to fit air-tight over the vessel.

The dropping tube, of which I have already spoken, will also serve to put in the bromine vessel a certain definite

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* According to Chevalier, to obtain a saturated solution, the bromine ought to be in contact with the water for at least twenty-four hours.—W. T.

† The most convenient apparatus for this purpose is the graduated syringe &c., shown at Fig. 27. ‡ See Fig. 27.

quantity of the bromine water ; it ought to be of such a size that the quantity of liquid it will contain, will quite cover the bottom of the vessel.

III. *Method of use.*—I have before stated, that it is necessary to expose the plate to the vapour of a solution of bromine of a certain strength for a definite time ; now for bromine water to be employed of the same strength for successive trials, it is evident it must be renewed for each experiment, which will be found the only means to insure a constant rate of evaporation.

The time a plate ought to remain over the bromine water will vary according to the size of the box, the surface for evaporation, &c., but for the same apparatus, it is constant ; with bromine water, of the strength I have pointed out, the time ought to be comprised between 30 and 60 seconds, according to the apparatus ; a few trials will determine the requisite time once for all, as the box cannot alter.

I shall now point out, in as few words as possible, the method of proceeding.

First.—Place upon a table the bottom of the box holding the bromine vessel or capsule ; fill the dropping tube with the bromine water, and pour it into one corner of the capsule, after having slid the glass cover sufficiently off, so that the point of the dropping tube can just be introduced, then return the glass to its place ; if the apparatus is not on a horizontal plane, it must be adjusted by the screws attached to the bottom, being guided by the colour of the bromine water seen through the plate glass cover ; when the bromine vessel is horizontal, and the liquid uniformly spread over its surface, complete the box by placing the second piece upon the bottom.

Every thing being thus arranged, and the plate iodized, with one hand uncover the capsule, with the other carefully place the plate upon the box, and immediately begin to count the number of seconds ; it is as well to change the position of the plate when about half the time of exposure has expired, so as to equalize the action of the bromine.

For a second trial the small quantity of bromine water ought to be thrown away, and replaced by a similar quantity of fresh ; the time of exposure will remain the same, and the successive plates will always be of an equal degree of sensibility.

THE HUNGARIAN MIXTURE.

As this mixture, the preparation of which is kept a secret by M. Guerin, has been much used with very great success by many persons for increasing the sensibility of the iodized plate, I have added the following directions for its employment, as described by N. P. Lerebours.

This preparation ought to be mixed with ten or twelve times its volume of water, and kept in a well-stopped glass-bottle.

When required for use, pour a small quantity into a bromine pan, and leave the plate, previously iodined, of a bright golden yellow colour, exposed to its vapour, till it assumes a bright rose tint. If small white spots form on the surface of the plate, it is a sign that the mixture is too strong, and requires to be mixed with more water.

CHLORIDE OF BROMINE.

This very sensitive preparation is most conveniently made by mixing two drachms of a saturated solution of bromine with fifteen drops of strong muriatic acid and ten ounces of water. This mixture can be kept in a stopped bottle, and when required to be used, a small quantity is to be poured into a bromine pan; and the plate, after being iodized of a clear yellow colour, should be exposed to the mixture, till it assumes a rose tint; then return it for a few seconds to the iodine-box before shutting it up in the sliding frame of the camera.

The same mixture will last for a considerable length of time, if it be returned to the bottle after each series of experiments.

BROMIDE OF LIME, &c.

Mr. Bingham, of the London Institution, has proposed the combination of bromine and its compounds with hydrate of lime, by which a dry powder is obtained possessing all the properties of such combinations in their liquid state. The bromide of lime, chloro-bromide of lime, &c. are easily made by allowing dry hydrate of lime to absorb the vapours of the different compounds, or else by adding them to a quantity of the dry hydrate of lime contained in a mortar, the whole is then quickly rubbed up together and put in a stopped bottle for use. It is employed in the same manner as the liquid preparations, a small quantity being placed at the bottom of the bromine apparatus.

OXIDE OF CHLORINE AND BROMINE VAPOUR.

In all the foregoing processes for giving the iodized plate its required degree of sensibility, the exact time of exposure to the various vapours is of the greatest consequence, so as to obtain a successful result. To avoid the necessity of so much exactness in regard to time, the following elegant method of preparing the plate has been proposed, and will be found to answer most completely.

A portion of iodine is first dissolved in a small quantity of rectified Persian naptha, and the solution poured on a slab of plaster of Paris, about the size of the plate to be prepared; the naptha quickly evaporates, leaving a coat of iodine. The slab thus prepared is placed at the bottom of a shallow box, the upper part of which contains the plate. When the plate has assumed a yellow colour, it is ready to be subjected to the action of a certain definite quantity of mixed bromine vapour and oxide of chlorine.

The *bromine vapour* is prepared by filling a bottle about a quarter full of concentrated sulphuric acid, and adding a small quantity of pure bromine; then, on agitating the bottle, the upper part will become filled with dry vapour of bromine.

The *oxide of chlorine* is prepared by adding a crystal or two of chlorate of potash to a small quantity of concentrated sulphuric acid, contained in the bottom of a small wide-mouthed stopped phial; an energetic action takes place between them, and a deep yellow gas (oxide of chlorine) fills the upper part of the bottle. As this gas is rather of an explosive nature, only a small quantity should be prepared at a time, and the bottle containing it kept in a cool place.

The apparatus necessary for applying these gases is shown at Fig. 27,* and is used in the following manner:—Remove the stopper from the bromine bottle, and introduce the point of the graduated syringe; raise the piston a certain number of divisions, which will cause a corresponding volume of the bromine vapour to be drawn in; then remove the syringe from the bromine bottle, and proceed, in like manner, to draw up about an equal bulk of the oxide of chlorine, the syringe will now contain a certain quantity of two gases, and it will be found an advantage, after measuring in the two gases, to raise the piston still higher, so as to mingle them completely, by drawing in a small quantity of atmospheric air. The glass

* See description of apparatus.

slide must now be slightly removed, so as to allow the point of the syringe to be introduced; then depress the piston, so as to force but its contents into the vessel, which done, withdraw the syringe, and immediately replace the glass cover. The apparatus should not be disturbed for a few seconds, so that the gas may diffuse itself equally in the vessel. The iodized plate may now be placed in its proper position at the top of the apparatus; and the sliding glass cover being removed, it becomes exposed to the action of the mixed gases, which it immediately begins to absorb. The plate is usually ready to be placed in the camera in about one minute; but it must be obvious that no evil can result if the plate be exposed under these circumstances for any length of time, as it cannot absorb more of the gases than was originally introduced into the apparatus by the graduated syringe.

The quantity of mixed gases requisite for the various sized plates is best ascertained by an experiment or two. However, to give some idea of the proper quantity, a plate three inches by four requires about $\frac{3}{100}$ths of a cubic inch of the mixture of bromine vapour and oxide of chlorine.

The plate, after being prepared by one or other of the foregoing processes, must be returned to the dark box till required for the next process, viz.:—

III. *Exposing the prepared Plate to the focus of a Refracting or Reflecting Camera.*—The mode in which this is effected must, of course, depend upon the construction of the camera, whether it have a lens, as originally proposed by Daguerre, or a concave mirror or speculum, which the apparatus patented in this country by Mr. Beard; both kinds have their advantages. The refracting camera, as recently improved (see list of apparatus), appears to possess all the capabilities without many of those inconveniences which attend on the manipulation with the reflecting camera, and, being withal less expensive, is now the form generally used.

The first thing to be attended to, before introducing the plate, is to place the camera on some firm support,* and opposite to the object wished to be copied; after which the focus should be adjusted with the greatest care till a perfectly clear and distinct image of the object is seen on the piece of ground-glass, which should be placed in exactly the same position as the plate is to occupy, taking especial care that the ground-side of the glass should correspond to the prepared surface of the plate. When the focus is obtained, the light should be

* See Figures 19, 20, and 21.

shut off by a contrivance for that purpose till the plate is introduced, or the camera may be taken into a dark room, and have the plate put into its place, when it can be brought into the light, having, of course, made those obvious arrangements that the object and the camera be placed in precisely the same relative positions they occupied when the focus was adjusted.

The camera may then be opened to allow the light to fall on the plate through the lens. The time requisite for it to remain open will depend, in a great measure, upon the season of the year, time of the day, and the brightness or clearness of the atmosphere. The time usually required with a good achromatic, and a well-constructed camera, varies from one to sixty seconds.

When the camera has been opened a sufficient time, which can only be determined by observation and experiment, close the front aperture, and take it into a dark room, when the picture, which is impressed on the sensitive surface of the plate, is to be made visible by being exposed to the fumes of mercury.

4. *Mercurializing the Plate.*—The apparatus required for this operation is called a mercury-box, and is used as follows:—Pour a small quantity of pure mercury (four to six ounces) into the metal cup at the bottom of the box; the mercury should then be heated by means of a spirit-lamp, till you can just bear to touch the metal cup outside. The plate may then be taken from the camera and placed in the mercury-box; and, after a short time, by cautiously applying a lighted paper to the side, and looking through the glass in front, you will be able to see how the picture is progressing.

If the mercury be made very hot, the picture soon makes its appearance; but, generally speaking, when done too rapidly, the minor details are lost, and the plate is apt to become spotty; it is always advisable, where time is not a great object, to do the operation rather slow than otherwise, as a much clearer and sharper outline of the picture will be obtained by this means than if done rapidly. The usual time required is from five to twenty minutes.

The mercury should be perfectly dry and free from any particle of oxide, and should be poured into a bottle after each series of experiments. When it loses its brilliancy, it may be purified by filtering through a paper cone, having a very fine opening at the bottom. The mercury-box ought also to be carefully dusted out before using.

5. *Setting the Picture.*—When the plate has remained long enough in the mercury-box, or till the picture has become sufficiently distinct, it should have its sensitive coating removed by washing in a solution of hyposulphite of soda. The solution recommended by N. P. Lerebours is made by dissolving two ounces of chrystalized hyposulphite of soda in a pint of distilled water, and then carefully filtering the mixture so as to remove all particles of dust.*

The plate should first be placed in a vessel of *filtered*, distilled, or boiled water, and then immersed in a second vessel containing a sufficient quantity of the solution of the hyposulphite to completely cover it; the plate should be agitated in the solution till the coating of iodide of silver is removed, which will be in a very few seconds, and afterwards returned to the first vessel, so as to remove the adhering solution of hyposulphite. If the plate be a large one it should be laid on a smooth and clean piece of tin or copper, after being removed from the hyposulphite, and some boiling distilled water poured over its surface, at the same time inclining the plate so that the water may run off from one of its lower corners, and it will in a very short time become perfectly dry.

If the plate be of a small size, it can be conveniently dried over a spirit lamp. On being removed from the hyposulphite, it should be held, by means of a small pair of pliars, by one of its corners, and some filtered distilled water poured over its surface; by inclining the corner held by the plyers, the greater portion of the liquid will flow to that part, and can be removed by touching it with a piece of rag or blotting paper; the spirit lamp may then be applied to the upper corner of the plate till it begins to dry, and the flame gradually brought lower down, till the whole surface is finished. Gently blowing downwards on the plate will expedite the process, as well as prevent, in a great measure, the formation of spots; if these should appear, the plate must be washed and dried over again.

The daguerreotype picture thus produced ought to be protected from dust or anything touching the surface, as the least friction would destroy the impression. The simplest plan for this purpose is the following:—Procure a piece of card or Bristol board, and a piece of flat glass, both the exact size of the plate; with a sharp penknife cut out the centre of the card

* The solution of hyposulphite of soda will last for a considerable length of time, and after being used, ought to be filtered before it is returned to the bottle.

the size you wish the picture to be, place the rim on the surface of the plate, and put the piece of glass on it; a narrow slip of paper may then be pasted round the edge, so as to unite the two and prevent them from shifting their position. The picture by this means can be preserved for any length of time from dust and friction, the piece of interposed card preventing the glass from touching the face of the plate.

All daguerreotype pictures finished as just described, are very liable to accident, inasmuch as the difference of light and shade is entirely dependant on the adhesion of *minute globules of metallic mercury*, which attach themselves in a greater or less quantity, according to the varied intensity of the glare of light constituting the picture. To cause these globules to attach themselves more strongly to the plate, or combining them with some other metal, would, of course, have the effect of fixing and rendering these Daguerreotype impressions more permanent and less liable to injury.

Various methods have been proposed for this purpose. The best appears to be that invented by M. Fizeau, which not only perfectly fixes the picture, so that it can be gently rubbed without any injury, but also greatly increases the general effect, preventing, in a great measure, the unpleasant metallic reflection, and the necessity of viewing them in a particular light. The process as described by M. Fizeau is as follows :—

"Dissolve eight grains of chloride of gold in sixteen ounces of water, and thirty-two grains of hyposulphite of soda in four ounces of water; pour the solution of gold into that of the soda, a little by little, agitating between each addition. The mixture, at first slightly yellow, becomes afterwards perfectly limpid. This liquid now contains a double hyposulphite of soda and gold.

"To use this salt of gold, the surface of the plate should be perfectly free from any foreign substance, especially dust; consequently it ought to be washed with some precautions, which might be neglected if it was to be finished by the ordinary mode of washing.

"The following manner generally succeeds the best: the plate being yet iodized, and perfectly free from grease on its two surfaces and sides, should have some drops of alcohol poured on the iodized surface;* when the alcohol has wetted all the surface, plunge the plate into a basin of water, and after that into a solution of hyposulphite of soda.

* The alcohol used should be the strongest that can be procured. The ordinary alcohol being very liable to produce stains.

"This solution ought to be changed for each experiment, and to consist of about one part of the salt to fifteen of the water: the rest of the washing is done in the ordinary way, only taking care that the water should be as free as possible from dust.

"The use of the alcohol is simply to make the water adhere perfectly all over the surface of the plate, and prevent it from quitting the sides at each separate immersion, which would infallibly produce stains.

"When a picture has been washed with these precautions, the treatment with the salt of gold is very simple. It is sufficient to place the plate on a support,* and pour upon its surface a sufficient quantity of the salt of gold, that it may be entirely covered, and heat it with a strong spirit lamp; the picture will be seen to brighten, and become, in a minute or two, of great force. When this effect is produced, the liquid should be thrown off and the plate instantly dipped in water, washed and dried.

"In this operation the silver is dissolved, and the gold precipitated upon the silver and mercury, but with very different results; in effect, the silver which, by its reflection, forms the shades of the picture, is some way darkened by the thin film of gold which covers it, from which results a strengthening of all the darks. The mercury, on the contrary, which, in the state of an infinite number of small globules, forms the lights, is augmented, in its solidity and brightness, by its union with the gold; from which results a great degree of permanency, and a remarkable increase in the lights of the picture."

When a plate is finished by M. Fizeau's process, just described, it can be kept in a portfolio, and easily cleaned with a soft camel's hair pencil; and if an endeavour is made to remove the design with the finger, it can be done, but imperfectly and with difficulty. If the picture will not resist this trial on the edge of the plate, the operation ought to be repeated. It is always advisable when a picture is finished, to place it at once in a small glazed frame, so as to seal it from the dust and sulphur in the atmosphere.

It sometimes happens that while the plate is being heated, a film of silver detaches itself and swims in the liquid, of course destroying part of the picture. This accident is probably

* Figure 23.

owing to the oxidation of the silver while under the influence of too much heat.

The lamp should be removed as soon as small bubbles of air appear to form on the surface of the metal. When the picture is not perfectly fixed, it is better to make a second trial, rather than run the risk of spoiling a good picture by trying to fix it perfectly the first time.

CHAPTER VII.

COLOURING DAGUERREOTYPES.

As objects copied by the daguerreotype process are only represented in light and shade, not in the colours as they appear in nature, it has been suggested, after the picture has been set, to colour them by hand, similar to a painting, and certainly, when done in an artistic skilful manner, it produces a very pleasing effect. The simplest method is to use dry colours, ground extremely fine, with some dry gum or starch. The picture must be well set with gold, and the colour applied, or dusted on with a fine camel's hair pencil, taking up a very small quantity of colour at a time; when the desired tint is produced, breathing on the plate will cause the colour to adhere. Mr. Claudet's method is to mix a small quantity of the colour with spirit of wine, applying it to the plate with a camel's hair pencil, and if not sufficiently dark, some of the dry colour is applied over it, to which it will adhere—as a general rule, the colours should be applied very cautiously, as it is very difficult to remove them when once on the plate. The best colours to be used are carmine, chrome yellow, and ultra-marine, by combining which, any desired tint may be obtained.

The following process for tinting, and at the same time fixing the daguerreotype impression, is extracted from a paper in Silliman's Journal, by C. G. Page, Professor of Chemistry, Columbia College, U. S.

"The impression being obtained upon a highly polished plate, and made to receive, by galvanic agency, a very slight deposit of copper from the cupreous cyanide of potassa (the

deposit of copper being just enough to change the colour of the plate in the slightest degree), is washed very carefully with distilled water, and then heated over a spirit-lamp until the light part assumes a pearly transparent appearance. The whitening and cleaning up of the picture, by this process, is far more beautiful than by the ordinary method of fixation by a deposit of gold. A small portrait, fixed in this way more than a year since, remains unchanged. As copper assumes various colours, according to the depth of oxidation upon its surface, it follows, that if a thicker coating than the first mentioned can be put upon the plate without impairing the impression, various colours may be obtained during the fixation. It is impossible for me to give any definite rules concerning this last process; but I will state, in a general way, that my best results were obtained by giving the plate such a coating of copper as to change the tone of the picture—that is, give it a coppery colour, and then heating it over a spirit-lamp until it assumes the colour desired. I have now an exposed picture treated in this way at the same time with the two above mentioned, and it remains unchanged. It is of a beautiful green colour, and the impression has not suffered in the least by oxidation. For pure landscapes it has a pleasing effect, and by adopting some of the recent inventions for stopping out the deposit of copper, the green colour may be had whenever desired. In some pictures a curious variety of colours is obtained, owing to the varying thickness of the deposit of copper, which is governed by the thickness of the deposit of mercury forming the picture. In one instance, a clear and beautiful ruby colour was produced, limited in a well defined manner to the drapery, while all other parts were green. To succeed well in the first process, viz. that for fixation and the production of the pearly appearance, the impression should be carried as far as possible without solarization; the solution of the hyposulphite of soda should be pure and free from the traces of sulphur, the plate should be carefully washed with distilled water, both before and after it receives the deposit of copper—in fact, the whole experiment ought to be neatly performed, to prevent what the French significantly call *taches* upon the plate, when the copper comes to be oxidized."

CHAPTER VIII.

PORTRAITS, VIEWS, &c.

Portraits.—To obtain good portraits it is necessary that the time required for the sitter to remain perfectly still should be as short as possible, consequently the apparatus should be of the best construction, and the sitter placed in as light a situation as possible. The open air is the best position. In bright sunshine it is essential, and indeed generally, it will be found desirable to place a canopy of some light blue material over the sitter, so that its shadow may fall beyond the feet, and thus prevent the direct rays of the sun, which ought always to be avoided. If the portrait is taken in a room, the sitter should be placed before the open door or window, so that the features may be strongly illuminated. The sitter should assume an easy natural position, bringing all the parts of the body as near as possible to one plane; that is, the feet and hands should be kept as near a line with the face as possible, for if they project much beyond they will become enlarged and distorted by the camera, especially if it be of short focus. The same precaution must be observed with respect to all objects, such as vases, &c., that are wished to be introduced into the picture.

During the time requisite to remain perfectly quiet, when the camera is opened, the head should not alter its position,* the eyes ought to be directed to some distant object, and the mind, if possible, occupied with serious or agreeable thoughts, according to the expression required.

To give a finish to a portrait, it is necessary to have some kind of background, placed just behind the person, either a painted screen representing a view, or terrace, library, &c., can be used, or a plain background of some even colour, either of a dark or light shade, according to the colour of the dress or complexion of the sitter. A black or drab will be found the best colour for dark, and a light brown for the light background. The best height for the camera is about level with the sitter's eyes.

Views, &c.—For views and buildings, the best guide for the operator is the picture as represented on the ground glass of

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* A chair, having a support or rest for the head at the back, will be found very convenient for this purpose, Fig 22.

the camera. But if any great portion of the picture appears more brightly illuminated than the rest, as a bright sky, or white building, ascertain in what position some opaque body or thick handkerchief can be held before the lens of the camera, so as to prevent so great a quantity of light reaching the glass from that particular object, and hold the handkerchief in the position that has been thus ascertained, during some portion of the time the plate is exposed in the camera, which will tend to equalize the action of the light, and thus produce a better picture.

Engravings, &c.—To produce these very beautiful photographs, the only hints necessary to be attended to, are to place them in a good light, on a perfectly flat surface, which should be parallel with the lens of the camera, and they ought not to be covered with glass, which is apt, by its reflection, to injure the picture.

CHAPTER IX.

PHOTOGRAPHIC PHENOMENA.

The following detail of some interesting and instructive experiments, by Mr. G. Shaw, of Birmingham, is taken with his permission, from the *Philosophical Magazine* of Dec. 1844.

It is well known that the impression produced by light on a plate of silver, rendered sensitive by M. Daguerre's process, is wholly destroyed by a momentary exposure of the plate to the vapour of either iodine or bromine. Although this fact has long been known, the nature of the action by which so extraordinary an effect is produced, has not yet been satisfactorily explained. In the hope of elucidating this subject, a series of experiments were instituted, the results of which are recorded in the following remarks :—

A silver plate, prepared by exposure to iodine or its compounds with bromine, may be exposed to the vapour of mercury without being in any way affected by the process. If, however, the prepared plate be obviously exposed to light, or made to receive the luminous image formed in the *camera obscura*, the mercurial vapour attacks it, forming, in the former case, a white film, and, in the latter, a picture corresponding to the luminous image which had been allowed to fall on it.

If a prepared plate, after receiving a vertical impression by light, be exposed to the vapour of iodine or bromine, it is found that the vapour of mercury no longer attacks it, or, in other words, the impression produced by light is destroyed.

The first experiments made for the purpose of arriving at the cause of this phenomenon had reference to the relation between the time of the exposure to light, and the time of exposure to the vapour of iodine or bromine necessary to destroy the effect produced by light. Prepared plates were exposed in the *camera obscura* for a length of time, which, previous experiment, had determined to be sufficient for a full development of the picture. Some of those plates were exposed during two seconds to an atmosphere feebly charged with the vapour of bromine, while others were carefully preserved from contact with the vapours of iodine or bromine. The atmosphere of bromine employed was produced by adding thirty drops of a saturated solution of bromine in water to an ounce of water. The solution was poured into a glass vessel, and the plate was exposed to the vapour in the vessel during the time specified. The plates were then introduced into the mercury-box, and, by volatilizing the metal, pictures were developed on all those which had not been exposed to the vapour of bromine, while those which had been exposed to it exhibited no trace of a picture under the action of mercury.

The same experiments were repeated with iodine, with exactly similar results.

Prepared plates were exposed to diffused light in the shade, and others were exposed to the direct rays of the sun, the object being in both cases the production of a more intense impression than that produced by the feeble light of the *camera obscura*. Some of these plates were exposed to the vapour of bromine, and others to the vapour of iodine, while others were carefully preserved from the vapours of these substances. On subsequent exposure to the vapour of mercury, those plates which had not been exposed to iodine or bromine, exhibited by the large quantity of mercury which condensed on them, the effects of exposure to intense light; while those which had been subjected to the action of either bromine or iodine were in no way affected by the vapour of mercury. Many repetitions of these experiments demonstrated that the effect of exposure to the most intense light was completely destroyed by the shortest exposure to the vapour of bromine or iodine.

Experiments were now instituted for the purpose of ascertaining in what condition the prepared plate was left after

having been first exposed to light and afterwards exposed to the vapour of bromine or iodine. In these experiments a method of treatment somewhat different from, and more convenient than that described, was resorted to, as in practising that method, effects occasionally presented themselves which interfered with the results, and rendered it difficult to determine with certainty, how far some of the appearances produced were due to the action of light. It is well known that a prepared plate has a maximum of sensitiveness when the iodine and bromine are in a certain relation to each other. If there be a deficiency of bromine, the maximum sensitiveness is not obtained, and, if there be an excess, the plate is no longer sensitive to light; but when exposed to the vapour of mercury, *without having been exposed to light,* becomes white all over by the condensation of mercury thereon—that is to say, it exhibits the appearance of a plate which had been *properly* prepared, and which *had* been exposed to light. From this it will be evident that a plate properly prepared in the first instance, and then exposed to light, may, by subsequent exposure to the vapour of bromine, have the impression produced by light *wholly destroyed;* and yet, by the accumulation of bromine, may exhibit, on exposure to mercury, an appearance similar to that due to light. In other words, it is impossible (in the case supposed) to distinguish between an effect produced by light and an effect due to excess of bromine. By using iodine in the place of bromine, there is no risk of producing the appearance which accompanies excess of bromine; but, on the other hand, by augmenting the quantity of iodine, the sensitiveness of the plate is diminished. These difficulties were overcome by using a solution containing both iodine and bromine in such proportions that the evaporation of each should take place in the proportion in which they produce on silver the most sensitive surface. The solution employed was made by adding alcoholic solution of iodine to a solution of chlorate of potash, until the latter would take up no more of the former, and to each ounce, by measure, of this solution ten drops of a saturated solution of bromine in water were added. The solution of chlorate of potash was made by diluting one part of a saturated solution of the salt with ten parts of water. The use of the chlorate is simply as a solvent of iodine. In the subsequent experiments, the plate was exposed to the vapour of this mixture of iodine and bromine with precisely the same effect as when either was used separately, and without the inconvenience or uncertainty which attended their use.

A number of preliminary experiments, the detail of which would be uninteresting, appeared to indicate, that not only

is the effect of light on a daguerreotype plate destroyed by iodine or bromine, but that the plate is restored to its original condition; in other words, that its sensitiveness to light is restored. In order to determine this point, the following experiments were made:—

A prepared plate was exposed to light, and afterwards to the mixed vapour;* mercurial vapour produced no effect upon it after a long exposure; the plate on removal from the mercury box was a second time exposed to light, and again introduced into mercurial vapour. The appearance of the plate was very little changed, and it was concluded that no effect, or, if any, very little, was produced by the second exposure to light. This conclusion was, however, erroneous, as the following experiments proved:—

A prepared plate was exposed to light, and afterwards to the mixed vapour; mercurial vapour was found to have no effect upon it; the plate was then partly covered with a metallic screen, fixed close to but not in contact with it, and the whole was exposed to light. On placing the plate in the mercury box, a broad white band, nearly corresponding to the edge of the defended part, made its appearance; the whole of the defended part (excepting the band in question) was unaffected, and the exposed part exhibited very little change. By a careful examination of the plate after it was removed from the mercury box, the white band in the middle appeared to be produced by the feeble light which had passed under the edge of the metal plate, which had screened the light from part of the prepared surface; and the very dark, and apparently unaltered appearance of the exposed part, was occasioned by an excess of action, for mercury was found to have condensed on that part in large quantities, and to have produced the dark lead colour which is commonly called *solarization;* but which effect, in the case in question, was so excessive, that the colour of the part on which mercury had condensed, differed but very slightly from that on which no light had fallen. It was now evident that the apparent absence of effect in the last experiment was in reality occasioned by an excess of action; and by repeating that experiment, and making the time of the second exposure to light much shorter than before, the plate assumed, under the action of mercury, an intense and beautiful whiteness.

* I shall hereafter call the mixed vapours of iodine and bromine, produced in the way described in the last paragraph but one, *mixed vapour*, in order to avoid circumlocution.—G. S.

From these experiments, then, it was perfectly clear that the impression produced by the light on a daguerreotype plate is wholly destroyed by the mixed vapour, and that *its sensitiveness to light is restored.*

It now remained to discover to what extent the sensitiveness is restored by the treatment in question. It was not at first expected that the sensitiveness to light was as great after this treatment as after the original preparation of the plate; but experiment afterwards proved, that the surface lost none of its sensitiveness by this treatment, nor even by numerous repetitions of it. A prepared plate was exposed to light; the impression was destroyed and sensitiveness restored by the mixed vapour; the plate was a second time exposed to light, and a second time to bromine; still its sensitiveness appeared unimpaired—for a fourth or fifth exposure gave, on treatment with mercurial vapour, a vivid impression. In order to determine with the greatest accuracy if the sensitiveness of the prepared surface was at all impaired by these repeated exposures to light, the *camera obscura* was resorted to. A series of plates was prepared with the utmost attention to uniformity; some of these were exposed in the *camera obscura*, and pictures obtained by the subsequent exposure to vapour of mercury; the time requisite for the proper development of the picture was noted, others were first exposed to the direct rays of the sun, and afterwards to the mixed vapour, and these were exposed in the *camera obscura* for the same length of time as those which had not been exposed to light. On treatment with mercurial vapour, perfect pictures were produced, which could not be distinguished from those taken on plates prepared by the ordinary method. So completely does the mixed vapour restore the sensitiveness of prepared plates after exposure to light, that the most beautiful impressions were obtained in the *camera obscura,* in two seconds, on plates which had previously been *four* times exposed to the direct light of the sun, and after each such exposure treated with the mixed vapour.

As the plates experimented on, to this stage of the inquiry, had been *wholly* exposed to the sun's light previous to exposure in the *camera obscura*, it was thought that possibly some slight effect was produced, which, from being the same on all parts of the plates, escaped observation; and in order to avoid the possibility of error from this cause, the impressions of light which it was intended to destroy by bromine, were afterwards made in the *camera obscura*. Prepared plates were impressed with virtual images of different kinds, the *camera*

obscura being pointed first at a house, afterwards to a bust, next to a tree, and finally to a living figure; the plates after each impression, excepting the last, being momentarily exposed to the mixed vapour. In every instance the most perfect impressions of the objects to which the *camera obscura* was last directed were obtained, and no trace of the previous impressions was left.

Experiments were next instituted for the purpose of ascertaining if the prepared surface, *after* the process of mercurialization, could be made to receive another impression by treatment with mixed vapour. Impressions were taken with the *camera obscura,* and after the full development of the picture by vapour of mercury, the plates were exposed to bromine, and again placed in the *camera obscura*, the instrument being directed in different experiments to different objects; on exposure to mercurial vapour other pictures made their appearance, and although confused from superposition on the first pictures, could be clearly traced, and were found perfect in every part. This production of picture upon picture was repeated, until, by the confusion of the superposed images, the effects of further exposure could be no longer distinguished.

In all the experiments hitherto described, the destruction of the impressions by bromine was effected in the dark, the apparatus being situated in a room into which only a very feeble daylight was admitted. It remained to be discovered if the mixed vapour had the power of destroying the effect of light while the plate was still exposed to light, or if the vapour had the power of *suspending* or *preventing* the action of light on a daguerreotype plate. In order to determine this point, the apparatus was placed near the window of a well-lighted room, and so arranged, that during the whole time of the preparation of the plate, by exposure first to iodine and afterwards to bromine, it was exposed to full daylight, and by a mechanical arrangement, of too obvious a nature to render description necessary, the plate was withdrawn from the bromine vessel into a dark box; that is to say, it was withdrawn at the *same moment* from the influence of both light and bromine; on being placed in the *camera obscura*, plates so prepared received impressions, which by mercurialization produced excellent pictures, and there was no trace of the action of any light save that of the *camera obscura*. It follows then, that light is incapable of exerting any appreciable influence on daguerreotype plates during the time they are receiving their coatings of iodine and bromine.

Although these experiments afford no information on the subject in reference to which they were originally undertaken, they are yet not without interest, both in their theoretical bearing and in their practical application. They demonstrate not only that the change (whatever it may be) effected by light on silver plates prepared by Daguerre's process is completely suspended in the presence of the vapour of either iodine or bromine, but that after that change has been produced, the impression may be destroyed, and the plate restored to its original condition by a momentary exposure to either of these vapours. In their practical application these experiments show, that all the care which has been taken to exclude light from daguerreotype plates during their preparation is unnecessary; that so far from a dark room being essential to the operations of the daguerreotype artist, the light of day may be allowed to fall on the plate during the whole time of its preparation; and that it is only necessary to withdraw it at the same moment from the action of bromine and light by sliding it from the bromine vessel into the dark box into which it is carried to the *camera obscura*, and where, from the situation or otherwise, there is a difficulty in observing the colour of the plate during the process of iodizing, it may be removed from the iodine vessel and its colour examined by the direct light of the sun without risk or injury; for when returned to the iodine or bromine vessel for a moment, the effect of light is wholly destroyed.

Perhaps the most valuable practical application of these facts is in the use of the same plate for receiving several impressions. When, on taking the portrait or picture of any object liable to move, there is reason to suppose that the motion of the person or object has rendered the operation useless, it is not necessary to throw aside the plate on which the imperfect impression has been taken, and resort to the tedious process of cleaning and preparing another; it is only necessary to treat the plate in manner already pointed out, and it is again equal in every respect to a newly prepared plate; and this treatment may be repeated until, by the slow accumulation of too thick a film of iodide of silver, the plate no longer possesses the same degree of sensitiveness to light.

CHAPTER IX.

MULTIPLICATION OF DAGUERREOTYPE PICTURES.

Copies of daguerreotype pictures may be made by the camera in precisely the same way as the original were. The camera for this purpose must be of considerable length, because, if the copy is required to be of the same size as the original, they must each be at an equal distance from the lens, though on opposite sides. The cause of this will be apparent by reference to Fig. 2, and its explanation is what is pointed out—the principle of *conjugate foci.* The only point that requires particular attention is the manner in which the light falls on the daguerreotype to be copied; perhaps the best guide that can be given is to place it in that position in which it appears on the ground-glass—brightest and most free from any reflected light.

Very excellent copies of daguerreotype pictures may be made by depositing a surface of copper upon them by the electrotype process of about the thickness of card, which, on removal, will afford faithful representations of the daguerreotypes.*

Another very ingenious method of preserving copies of daguerreotypes on paper was proposed by Mr. George Edwards, and may, in some circumstances, be found of considerable utility. The following is the process:—

Procure some sheets of black paper, and brush them evenly over on one side with a rather strong solution of isinglass, or Nelson's gelatine; the sheets of paper ought then to be dried and kept ready for use between the leaves of a book, or in a portfolio. When a daguerreotype is to be copied, let one of the sheets of paper be placed in some cold water, till the gelatine on its surface becomes soft. It should then be carefully laid on the silver plate; and after first placing several folds of blotting-paper, and then a smooth board on the back of the black paper, subject the whole to a moderate pressure till dry. The paper, on being removed from the plate, will present a perfect representation of the original.

* See Mr. Alfred Smee's work on "Electro-Metallurgy."

The following modification of this process was invented by Dr. Draper, who has given it the name of *Tithonotype*.

The daguerreotype intended to be copied is to be covered with a thin flim of gold, in the usual way (Fizeau's), care being taken that the film is neither too thick nor too thin.

A clear solution of isinglass is next to be prepared, and of such a consistency that a drop of it placed on a cold metallic plate will speedily solidify.

This is to be particularly attended to, as much of the success of the operation depends on this solution being properly prepared.

The daguerreotype is to be supported with its face upwards, in a current of hot air rising from a stove; and whilst thus situated, the isinglass is to be poured on it until a stratum of about one-sixth of an inch has accumulated. It is then suffered to dry; the whole process occupying two or three hours. When successful, the film of isinglass, now indurated, peels off, and will be found to bear a minute copy of the original, and can be examined either by reflected or transmitted light.

CHAPTER X.

CRYSOTYPE.

This variety of photogenic drawing was discovered by Sir J. Herschell, and derives the name from χρυσος, gold, τυπος, a picture. The process is as follows:—Wash the paper to be prepared evenly on one side with a solution of ammonio-citrate of iron, in distilled water. This solution should be recently prepared, and of an amber colour. The paper will now be ready for use, and being in the usual way exposed to the light, the impression must be brought out by immersing it in a solution of chloride of gold, rendered neutral by carbonate of soda. The picture should then be well washed in water, and dried.

ANTHOTYPE.

It has been discovered also by Sir J. Herschell, that the expressed juice, alchoholic or watery infusions of the petals of

the wild poppy, double stock, rose, guaiacum, and several other plants, are affected by the action of light, which generally destroys their colour; if paper, therefore, be washed over and used as the ordinary photogenic paper, the result will be a positive picture of the same colour as the infusion, or expressed juice of the flower used. This process, which has been called, by its discoverer, "Anthotype," is very interesting, as it shows that the vital principle of plants prevents those changes of colour and properties which immediately takes place when that influence is destroyed.

CYANOTYPE, OR FERROTYPE.

This is a similar process to the crysotype, bringing out the picture with a solution of the ferro-cyanate of potash instead of the solution of gold. The result is a positive picture of a blue colour on a yellowish green ground. This process, which is a very delicate one, was also discovered by Sir J. Herschell, and is named from the circumstance that the combination of cyanogen and iron acts an important part in the operation.

ENERGEATYPE.

This name has been given by Mr. Hunt to a process of his which may thus be described: Paper is first washed over with a solution of 5 grains of succenic acid in one oz., of distilled water, to which must be added 8 grains of common salt and a half dram of mucelage of gum arabic;* when nearly dry, brush over it a solution of nitrate of silver containing one drachm of the salt to one oz. of water. The paper thus prepared, after being dried in the dark, may be exposed in the camera. On removal from the camera no traces of a picture will be perceived, and to develope the latent impression, it must be washed over by candle-light with a mixture of one drachm of a saturated solution of proto-sulphate of iron and two drams of mucelage of gum arabic, rubbing it pretty briskly over the surface with a camel's hair brush. When the picture is clear, let it be well washed in water, and afterwards set with hyposulphite of soda in the usual way.

The sulphate of iron has a similar effect on many other salts of silver besides the succinate, in bringing out any latent impression, and will be found very effective in bringing out the calotype picture INSTEAD of the second application of gallo nitrate of silver.

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* Made by dissolving one drachm of gum arabic in one oz. of distilled water.

THERMOGRAPHY.

If a copper coin be laid on a polished silver plate, and the plate be then slightly heated and allowed to cool, an impression will be formed of the coin on its surface, which will become perfectly visible on breathing over the plate. The figure will remain for many days, only requiring to be breathed on for it to become visible, and if the plate be exposed to the vapour of mercury, the impression becomes permanent.

Almost any substance laid upon a polished surface of metal or glass, slightly warmed, will give an impression when breathed on; the sharpness and clearness of which varies with the articles employed. A coin, for instance, allowed to remain on a looking-glass a few minutes, and breathed over two or three times, will, on the coin being removed, show its figure for several weeks by merely breathing on the surface of the glass, provided it be not rubbed during that time, which would destroy the impression.

The cause of these results is not known, but the discoverer, Mr. Hunt, has designated this peculiar impression by the name Thermography, derived from Θερμος heat, and Γραφω to write, from the circumstance that heat appears necessary for this production.

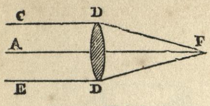


Fig. 1.

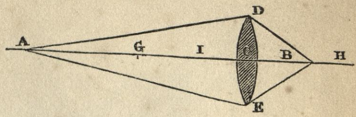


Fig. 2.

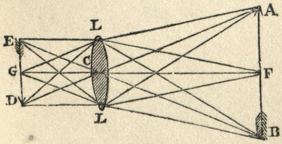


Fig. 3.

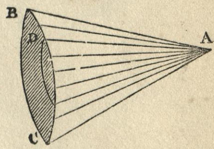


Fig. 4.

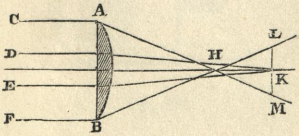


Fig. 5.

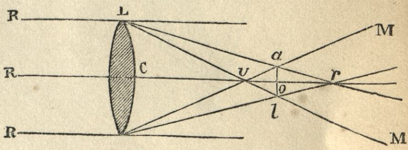
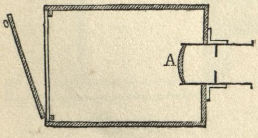


Fig. 6.



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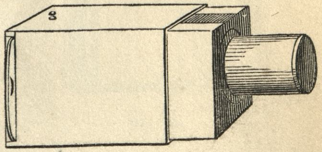

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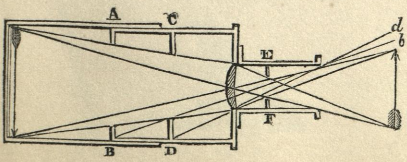

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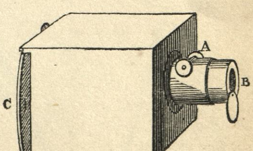


Fig. 10.

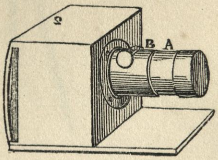
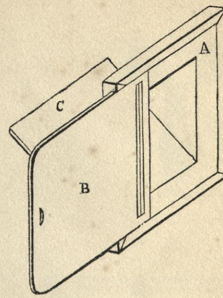


Fig. 11.



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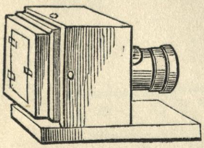

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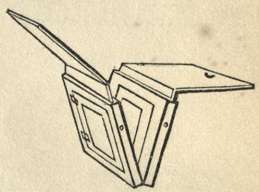

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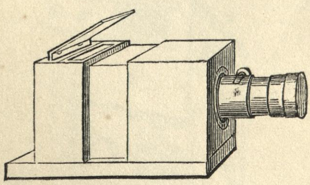

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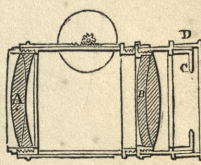
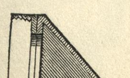


Fig. 16.

Fig. 17.



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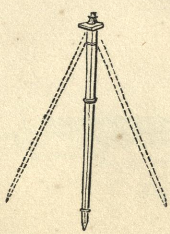

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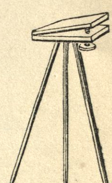

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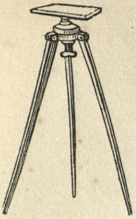

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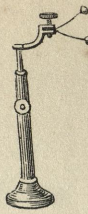

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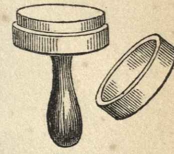

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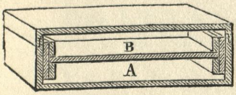

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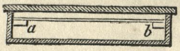

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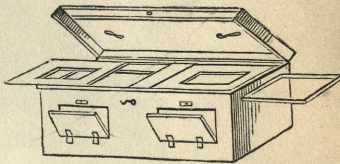

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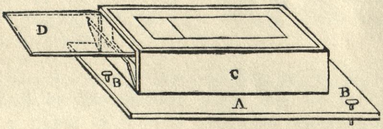

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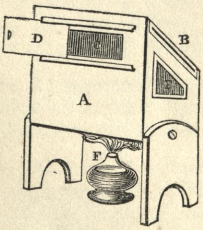
E.



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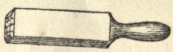

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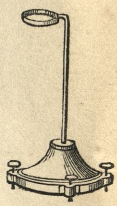

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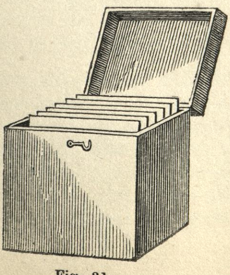

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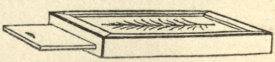

Fig. 32.

DESCRIPTION OF THE CUTS.

Figs. 1, 2, 3, 4, 5, and 6.—Diagrams to explain the optical principles of the transmission of light through lenses.

Fig. 7.—Sectional view of a photographic camera for paper, fitted with a meniscus lens, as shown at A.

Fig. 8.—Cundell's improved camera for the calotype process.

Fig. 9.—A sectional view, showing the utility of the various stops for cutting off all rays except those emanating from the object to be copied.

Fig. 10.—A camera fitted with a single achromatic lens, which is attached to the sliding tube A; at the back fits a frame holding a piece of ground glass for ascertaining the focus, and also a frame to hold the prepared plate or paper having a sliding shutter in front, so that it can be withdrawn when introduced into the camera, as shown at C. The focus is adjusted either by a simple sliding tube or by rackwork.

Fig. 11 represents a daguerreotype camera, it is furnished with a double achromatic object-glass, fitted in a brass front. The focus is adjusted to the greatest nicety by a fine rackwork movement, B.

Fig. 12 shows the construction of the ordinary frame for holding the prepared plate, which fits the back of the camera; A the metal frame, having a groove round its centre, into which the plate fixes; it is made perfectly square, so that the picture can be produced in either direction of the plate. B, a shutter sliding in front of the metal frame, to prevent the access of light to the plate till placed in the camera. C, a hinged flap to keep the plate and metal frame in their proper positions.

Fig. 13.—Horne and Co's. improved photographic camera, with patent back. This camera has a contrivance whereby the relative position of the plate and object-glass may be so adjusted as to obviate, in a great degree, the difference of focus that results from the different parts of the object to be copied, being at various distances from the object-glass. The frame at the back has two sliding shutters, and opens in the centre; by which contrivance

two prepared plates can be contained and employed in one frame, by merely reversing its position in the groove.

Fig. 14 represents this improved double frame, which is also applicable for holding prepared paper for other photographic purposes; and from the circumstance of its not being more bulky than the ordinary single frame, it recommends itself for its convenience in use.

Fig. 15 shows a photographic camera, the body of which is made to slide, by which contrivance two or more lenses, or combination of lenses, of different foci, can be used with the same instrument. This form of apparatus, when fitted with the improved moveable double-back, forms one of the most perfect photographic cameras that can at present be constructed.

Fig. 16.—A sectional view of the improved compound object-glass, consisting of two achromatic glasses, A B. The glass A, which is the one next the plate, is of a periscopic form; the other, B, which is directed to the object, is a double convex. In front of B, screws on a brass diaphragm or stop, C, which is used where extreme sharpness is required, and the rapidity of operation is of no moment. D, a brass cap for closing the aperture.

Fig. 17.—A plain mirror, which is screwed on to the brass front of the camera when the daguerreotye pictures are required to appear in the same relative position as they occupy in nature.

Fig. 18.—A glass prism for the same purpose.

Fig. 19.—Represents a very convenient form of portable tripod stand for supporting small cameras in any required position or height. A small brass plate is firmly fixed at the bottom of the camera, and has a screw cut in the centre, into which fits the pin of the ball and socket joint B. When the camera is placed in its required position, by turning the brass plate, C, it becomes firmly fixed. The legs D, D, D, fold together for adjusting the height, or for convenience of carriage.

Figs. 20 and 21.—Represent two form of camera stands, suitable for the support of large instruments; that shown at fig. 21, is the most complete, and has a large ball and socket joint, and fixing screw beneath, when the adjustment is completed.

Fig. 22.—Convenient form of support for steadying the head while taking a photographic portrait; it is placed behind the chair; the brass pillar can be elongated, and fixed in its required position by a large milled-head screw near the top, at the same time both of the lateral slides holding the pads, are capable of being adjusted to the side of the head.

Fig. 23.—A plate holder, for holding the plate while being cleaned or buff'd; it is made of hard wood; on the upper surface is cemented a piece of sheet caoutchouc, rendered sticky by being held over a flame for a few moments, or by the application of a hot iron. When the back of a plate is lightly pressed on this

surface, it becomes immediately fastened, but can as easily be removed when required, by first raising the corner of the plate. B is a cover to protect the adhesive surface; C, the handle, which can be unscrewed if required.

FIG. 24.—*The Iodine Box.*—It consists of a mahogany box lined with glass, with four projecting pieces of glass, near the top, for the corners of the plate to rest upon while being iodined. The box is either furnished with card at the bottom, to be saturated with a solution of iodine when going to be used, and a plate of glass to lay over it to prevent useless evaporation, or a quantity of iodine is spread over the bottom, and covered with one or two layers of cotton wool, A, over which is placed a piece of card-board, B, capable of being reversed when required. When a plate is to be prepared, the side of the card which is downwards, and consequently saturated with the vapour of the iodine, should have its position reversed, so that the evaporation from its surface may give an even coating to the plate. By this arrangement one surface of the card is always in a fit state for use, and will only require its position to be altered each time a trial is made. While iodizing a plate, the box ahould be covered with its lid, as it prevents the possibility of any draught of air, which might prevent the plate from being equally coated over its surface.

FIG. 25.—*The Bromine Vessel.*—It is made of glass or earthen-ware, and has two projecting ledges, A B, upon which the plate rests; the upper edge of the vessel is ground, so that a plate of glass or slate laid over it, may prevent evaporation. In using this bromine vessel, it should be adjusted as level as possible, so that the fluid placed in it may equally cover the bottom.

FIG. 26.—Represents the most convenient and improved form of apparatus for applying the iodizing and sensitive coatings to a daguerreotype plate. It consists of an oblong mahogany box, divided by a partition; in each division is fitted a square glass vessel, ground at the edge, and on which slides a plate-glass cover; on the upper edge of the box is a groove for the purpose of holding frames of various sizes for different sized plates; in the front of the box are two small mirrors, corresponding with two openings at the back, for the purpose of watching the action of the chemical preparations on the plate. The method of use is very simple: the iodizing and sensitive solutions are placed one in each glass vessel, and their respective covers slid over them; the wood frame having an opening of the size of the plate to be prepared is then put into the upper groove, and the polished plate laid face downwards in its proper place. The whole apparatus ought to be placed by a window, that the light may be admitted by the openings at the back of the box, and from the polished surface of the plate reflected to the front mirror, and from thence to the eye. On withdrawing the glass cover, the plate is immediately brought in contact with the iodizing vapour, and its colouring effect on the plate can be watched, and instantly stopped by replacing the cover. The frame and plate can now be slid over the partition so as to be acted on by the sensitive preparation, which is applied in precisely a similar manner to the iodizing.

Fig. 27.—*Apparatus for the application of Bromine vapour, or of Gas.*—It consists of a flat board A, in which is placed three screws B, two only of which are seen in the figure ; on the board is placed the box C, the top of which contains the frame for holding the plate to be prepared. One side of this box is hinged so as to allow it to fall as shown at B. Within the box C, is a shallow vessel of glass or earthenware, similar to a bromine vessel, ground on the upper edge, and furnished with a plate-glass cover, D, shown partially removed in the figure. So long as the plate-glass is over the interior vessel, the hinged side of the box must remain open, but simultaneous with removing the cover, the side can be shut, which will complete the box. E is a glass syringe, graduated into 100ths of a cubic inch, for measuring any definite quantity of bromine water, vapour, or gas.

Fig. 28.—*The Mercury Box.*—The body A is made of wood, and has an iron cup fixed in the bottom for holding the mercury, which is heated by a spirit lamp F ; the upper part of the box A is grooved, so as to receive the same sliding frame B that fits the back of the camera, and holds the prepared plate ; at the front of the box is a small glass window, C, over which slides a shutter, D ; there is also another small shutter at E, at which a taper is held while the development of the picture is viewed through the front glass.

Fig. 29.—*Velvet Buff.*—A piece of wood, from 14 to 18 inches long, and from 3 to 5 inches wide, covered with a fold or two of flannel, over which is sewn or tacked a piece of well-washed unbleached cotton velvet. The buff should be carefully kept from dust, grease, and damp, and therefore should not, on any account, be touched on the front surface with the fingers.

Fig. 30.—A stand for setting with the chloride of gold; it is made of brass, and has three levelling screws in the foot B, for the purpose of bringing the surface of a plate, placed on the ring A, to an horizontal plane, so as to allow the solution of gold to be poured on in sufficient quantity without running off.

Fig. 31.—Represents a form of box very convenient for preserving daguerreotype plates after they are polished, or when prepared ; each plate slides in a groove, thus preventing them injuring each other.

Fig. 32.—Frame and plate-glass for obtaining photogenic copies of leaves, feathers, &c., also used for making positive from negative photographs.